General Radio

INSTRUCTION MANUAL

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GR 1935 Cassette Data Recorder

(TYPE 1940 POWER SUPPLY AND CHARGER)

A

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Concord, Massachusetts, U.S.A. 01742
Form 1935-0100A
November 1974
ID-0100

Warranty

We warrant that this product is free from defects in material and workmanship and, properly used, will perform in full accordance with applicable specifications. If, within a period of ten years after original shipment, it is found, after examination by us or our authorized representative, not to meet this standard, it will be repaired or, at our option, replaced as follows:

- No charge for parts, labor or transportation during the first three months after original shipment;
- No charge for parts or labor during the fourth through the twelfth month after original shipment for a product returned to a GR service facility;
- No charge for parts during the second year after original shipment for a product returned to a GR service facility;
- During the third through the tenth year after original shipment, and as long thereafter as parts are available, we will maintain our repair capability and it will be available at our then prevailing schedule of charges for a product returned to a GR service facility.

This warranty shall not apply to any product or part thereof which has been subject to accident, negligence, alteration, abuse or misuse; nor to any parts or components that have given normal service. This warranty is expressly in lieu of and excludes all other warranties expressed or implied, including the warranties of merchantability and fitness for a particular purpose, and all other obligations or liabilities on our part, including liability for consequential damages resulting from product failure or other causes. No person, firm or corporation is authorized to assume for us any other liability in connection with the sale of any product.

Condensed Operating Instructions

Calibration and Recording

- Using the coiled cord, interconnect the GR 1933 Sound-Level Meter and Recorder.
- Set the ***1933*** dB LEVEL control (lower major control on side panel to your right) to align the CAL arrows on the MAX MIKE dB control (left-side panel).
- Select the 1-kHz octave band, using the BAND control (upper major control on right-side panel) and set the SOURCE control (under top cover) to CAL.
- Push the ON-OFF button to turn the instrument on. The meter should read at full scale, indicating that the instrument is in calibration and ready for use. If it does not, the reading can be adjusted using the CAL screwdriver control, on the top panel under the top cover.
- Place the ***1935*** RANGE CODE ON-OFF switch to ON and the dB FULL SCALE selector to AUTO (right-side panel).
- Press the STOP-EJ key on the Recorder, install a tape, and close the cover.
- Depress the FORWARD or REWIND keys to choose the desired portion of the tape. Note the counter reading or reset to 000, if desired, by depressing the button.
- Depress the RECORD and PLAY buttons simultaneously to select the record mode.

NOTE

The CHANNEL A panel meter should indicate at the CAL mark when the 1933 is at full scale. If it does not, the reading can be adjusted with the CAL A screwdriver control under the DATA IN connector, on the right-side panel of the Recorder.

- Record for approximately 30 seconds, then depress STOP to turn off the recorder. Include approximately 30 seconds of this CAL tone before recording acoustic data.

Playback

- Remove the preamplifier from the 1933 and connect the playback cable from the CHANNEL A output on the recorder to the mast connector on the Sound-Level Meter.
- Set the 1933 SOURCE control to TAPE and the dB number LEVEL control to the highest level range (fully cw).
- Rewind the tape and select PLAY. The CHANNEL A meter should indicate at the CAL mark and the 1933 meter should read full scale, when the CAL tone is being played back.
- Verify that the dB FULL SCALE display on the Recorder indicates the number that appeared in the farthest right window on the 1933 meter face, when the recording was made. (109)
- Press in the MAX MIKE dB control on the 1933 and turn until the farthest right window on the meter face indicates the dB number displayed on the recorder, without changing the Level Control knob setting on the 1933.

Recording Acoustic Data

- Mount the preamplifier and microphone on the 1933 and set the SOURCE control to A or B, depending on the microphone selected.
- Select WEIGHTING, using the BAND control, and depress the FLAT button.
- Adjust the dB LEVEL control to achieve and maintain a reading on the upper half of the meter scale. Select FAST or SLOW, as desired, by depressing the appropriate button.
- Record signals as desired.

Details in Section 2.

Specifications

Recording Format: 0.150-in.-wide tape cassette (Coplanar Type CPII), two-channel, two-track.

Normal Recording Duration: 30 minutes using C60 tape. TAPE SPEED: 1 7/8 in./s ±2%; electronically controlled.

Inputs: Input impedance at signal input, each channel, 100 kΩ. Signal level corresponding to normal maximum record level is adjustable from 0.5 to 3 V rms. RANGE CODE AND VOICE NOTES: Second channel normally records range code or voice notes simultaneously with data from a sound-level meter. Range code is provided automatically by 1933 Precision Sound-Level Meter and Analyzer or manually by switch on recorder. Voice-note input has 1 MΩ input impedance and automatic level control.

Frequency Response: Typically ±2 dB from 50 Hz to 12 kHz using GR 1935-9603 series cassettes. Guaranteed limits shown in graph. PLAYBACK EQUALIZATION. EIA Standard for coplanar type CPII (playback T.C. 1590 μs and 120 μs at 1 7/8 in./s.) FLUTTER AND WOW: 0.3% rms as tested in accordance with NAB Standard (April 1965). MAXIMUM SIGNAL TO NOISE RATIO: 50 dB minimum from 3% harmonic distortion to A-weighted noise level.

Output (each channel): 0.5 V behind 600 Ω corresponds to normal maximum record level (which allows 10-dB crest-factor capacity). Any load can be connected.

Peak Monitors: Both channels include peak detectors that monitor peaks of both polarities and display on panel meters.

Tape Position Counter: Built-in mechanical counter provides index number for relocating tape position.

Supplied: Head demagnetizer, head cleaning kit, interconnecting cables to 1933 Precision Sound-Level Meter and Analyzer, earphone, microphone for voice notes, cassettes, and batteries.

Power: 5 size-C energizers, supplied, provide about 10 hours' operation. 1940 Power Supply and Charger allows line operation of 1935 and recharges suitable batteries (included with power supply). The regular cells are Eveready E93 or equivalent; the rechargeable cells, Gould National Nicad Type 2.0 SCB, with insulating jacket.

Mechanical: DIMENSIONS (wxhxd): 6.5x10.87x3.56 in. (165x276x90 mm). WEIGHT: 7 lb (3.2 kg) net.

Environmental Data: TEMPERATURE: 10° C to 50° C operating, –40° C to +60° C storage with batteries and tape removed. HUMIDITY: 0-90% RH operating. SHOCK: 30 G, 11 ms. DROP 30 in. (in shipping container).

Description	Catalog Number
Cassette Data Recorder	**1935-9700**
Cassette, 30-minute	**1935-9603**
Power Supply and Charger	**1940-9701**
Replacement Batteries	
Regular (5 req'd)	**8410-1500**
Rechargeable, set of 5 cells	**1940-9500**

1940 Power Supply and Charger

Power Source: 5 V for line operation of 1933, 6.5 V for line operation of 1935; 250 mA max.

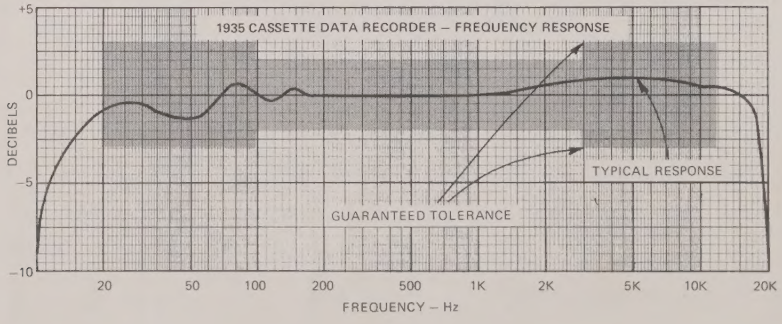
Charging Source: 200 mA max for charging batteries in 1933 or 1935; automatically reduces to ≈ 30-mA trickle charge when batteries are charged. Charging time ≈ 16 h.

Supplied: 5 rechargeable nickel-cadmium C cells to replace non-rechargeable batteries in 1933 or 1935.

Power: 100 to 125 or 200 to 250 V, 50 to 400 Hz, 11 W.

Mechanical: DIMENSIONS (wxhxd): 4.38x4.25x9.44 in. (111x108x240 mm). WEIGHT: 3.5 lb (1.5 kg) net, 5 lb (2.3 kg) shipping.

Description	Catalog Number
1940 Power Supply and Charger	**1940-9701**



Introduction—Section 1

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1.1 PURPOSE.

The 1935 Cassette Data Recorder is intended as an accessory recorder to be used with the 1933 Precision Sound-Level Meter and Analyzer and virtually all other sound-level meters. It is light weight, readily portable, and intended for use in recording the output signal provided by the sound-level meter. The recording is then played back for listening or to supply a signal to the 1933 or any other spectrum analyzer having a bandwidth of 1% or more, at the frequency to which it is tuned.

1.2 DESCRIPTION.

The 1935 is a portable, two-channel, two-track, magnetic tape recorder using the Philips Cassette format. In use with the 1933 Precision Sound-Level Meter and Analyzer, the 1935 records the signal on one channel, while on the other it records the setting of the sound-level meter range control. The signal and range information given on playback are identical to those available from the sound-level meter at the time of recording. Voice notes can be recorded by breaking into the range code.

Although intended primarily for use with the 1933 Precision Sound-Level Meter and Analyzer, the Recorder can also be used with any instrument that provides an output signal in the range from 0.5 to 3.0 V rms at full scale. In this case, the range information is entered manually. If desired, both channels can be used to record the signals from two sound-level meters. In this case, range information will not be recorded. Each channel includes a panel monitor that displays the absolute peak level regardless of polarity, so that proper recording level can be maintained at all times.

1.3 CONTROLS, CONNECTORS, AND INDICATORS.

Controls, connectors and indicators on the 1935 are listed and described in Tables 1-1 through 1-4 and shown in Figures 1-1 through 1-4.

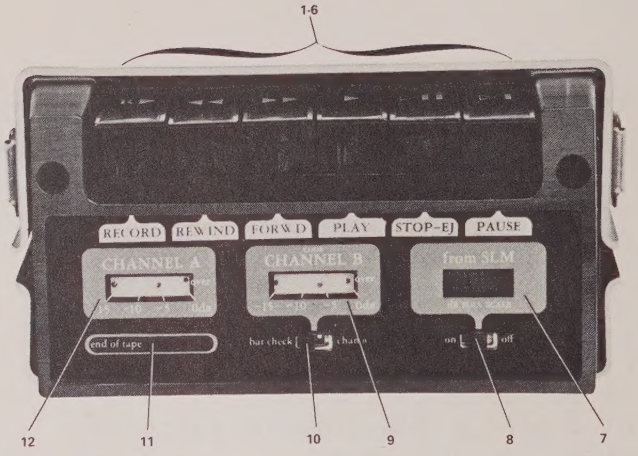

Figure 1-1. Controls and indicators — end view.

Table 1-1
FRONT-PANEL CONTROLS AND INDICATORS

Fig. 1-1 Ref. No.	Name	Description	Function
1 through 6	Tape function keys	6 Keyboard buttons	Selects Tape Function. Left to right: 1. RECORD selects record mode of operation; interlocked with play button. 2. REWIND causes tape to wind on supply reel. 3. FORWD causes tape to wind on takeup reel. 4. PLAY allows playback of previously recorded tape. 5. STOP-EJ. Slight depression stops tape and turns off all electronics. Hard depression stops tape and ejects cassette from holder. 6. PAUSE. Stops tape but allows electronics to maintain function. Works only in RECORD or PLAY mode.
7	from SLM-dB FULL SCALE	3-Digit LED display	Indicates setting of dB Full Scale switch (40 to 140 dB) or indicates Full Scale dB of 1933 SLM when dB Full Scale switch is in AUTO and 1933 SLM is connected to DATA IN jack via interconnecting cable (1935-0231). Display provides an indication both during record and playback.
8	on/off	2 position slide switch	Turns off dB FULL SCALE display when not needed, to conserve battery.
9	CHANNEL B meter	Recessed meter with dB scale	Indicates the absolute peak level of Channel B Record and Playback signals with respect to tape overload level. Indicates condition of battery when BAT CHECK/ CHAN B switch is set to BAT CHECK.
10	bat check/chan B	Miniature slide switch	Selects Battery condition or Channel B level to be indicated on CHANNEL B meter.
11	end of tape	Recessed light-emitting diode	Shines red when end of tape is reached. Electronics of Recorder is also turned off.
12	CHANNEL A meter	Recessed meter with dB scale	Indicates the absolute peak level of Channel A Record and Playback signals with respect to tape overload level.

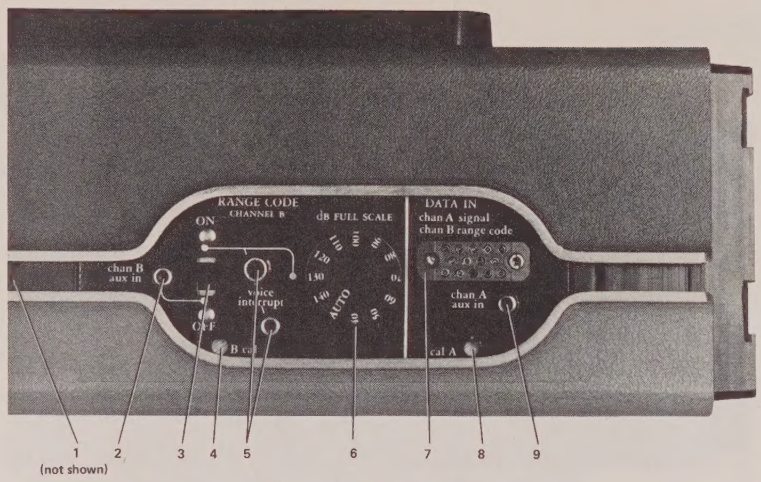

Figure 1-2. Controls and connectors — side view.

Table 1-2
RIGHT-SIDE PANEL CONTROLS AND CONNECTORS

Fig. 1-2 Ref. No.	Name	Description	Function
1 (not shown)	Channel B playback	Recessed screwdriver control	Adjusts gain of channel B playback amplifier.
2	chan B aux in	Miniature phone jack	100-kΩ input for SLM signal when RANGE code switch is off. 0.5-3.0 V rms input range corresponding to full-scale on sound-level meter.
3	RANGE CODE CHANNEL B ON/OFF	2-Position slide switch	Selects the use of channel B as data channel (AUX INPUT), or as a range code channel.
4	B cal	Recessed screwdriver control	Adjusts record level of channel B auxiliary input such that full-scale SLM reading produces an indication of CAL on CHANNEL B meter. V Range, 0.5-3.0 V rms.
5	voice interrupt	Two miniature jacks	Accepts plug-in voice microphone. Large jack transmits mike signal. Small jack transmits signal that will interrupt code operation and allow voice notes to be recorded on channel B.
6	dB FULL SCALE	12-position rotary switch	Selects range code to be recorded on channel B. Manually selects 40-140 dB. In AUTO position accepts signals from 1933 via DATA IN connector.
7	DATA IN chan A signal chan B range code	14-pin connector	Accepts binary-coded data from 1933 SLM for range code. Provides binary-coded range code from recorded tapes. Accepts SLM input for channel A. Provides channel A output with 0.5 V rms behind 600 Ω, corresponding to Normal Maximum Recorded Level (CAL) on a recorded tape. Any load permitted.
8	cal A	Recessed screwdriver control	Adjusts record level of channel A input such that full-scale SLM reading produces an indication of CAL on CHANNEL A meter. Range, 0.5-3.0 V rms.
9	chan A aux in	Miniature phone jack	100-kΩ input for SLM signals to be recorded on channel A. Wired in parallel with DATA IN input. Range, 0.5-3.0 V rms.

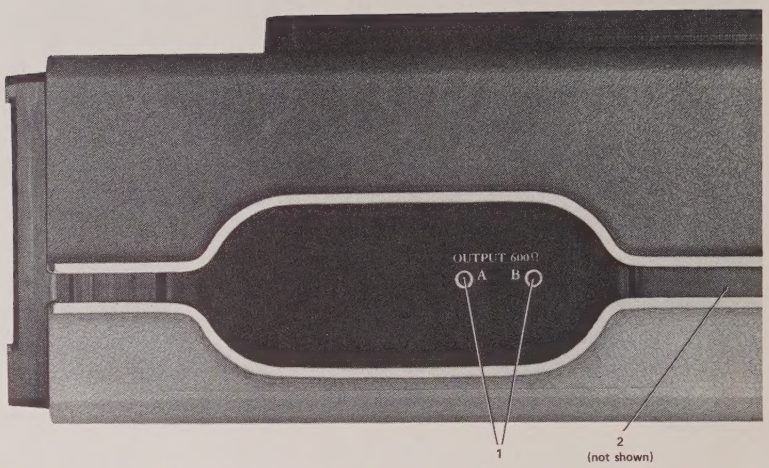

Figure 1-3. Controls and connectors — side view.

Table 1-3
LEFT-SIDE PANEL CONTROLS AND CONNECTORS

Fig. 1-3 Ref. No.	Name	Description	Function
1	OUTPUT 600 Ω A B	Miniature phone jacks	Provides ac signal output of 0.5 V rms behind 600 Ω corresponding to Normal Maximum Record Level (CAL) on tape, any load permitted.
2 (not shown)	Channel A playback	Recessed screwdriver control	Sets gain of channel A playback amplifier to give 0.5-V rms output for a reference tape level.

Table 1-4
OTHER CONTROLS, INDICATORS AND CONNECTORS

Fig. 1-4 Ref. No.	Name	Description	Function
1	Battery connection	10 Spring battery contacts	Make connection to 5 cells (Alkaline or rechargeable NICAD). Sliding panel covers and holds cells in place.
2	————	Cassette tape holder	Compartment pops up when STOP/EJ button is pressed hard, permitting cassette to be placed into and removed from holder. Holder is pressed down to put cassette in place for recording and playback.
3	————	3-digit mechanical drum display	Indicates relative position of tape.
4	————	Exposed pushbutton	Resets counter.
5	————	5 flush-mounted banana plug receptacles.	Connect battery and power leads to 1940 Power Supply and Charger for line operation and charging.
6 (not shown)	TRIPOD MOUNT	1/4-20 thread	Permits mounting recorder on tripod.

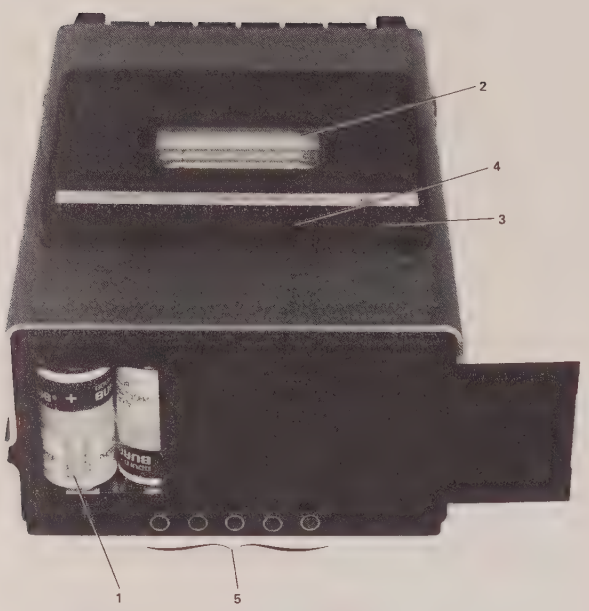

Figure 1-4. Controls, indicators and connectors — end view

1.4 ACCESSORIES SUPPLIED.

The accessories supplied with the 1935-9701 Cassette Data Recorder are listed in Table 1-5 and shown in Figure 1-5. (The C cells are not shown.)

Table 1-5
ACCESSORIES SUPPLIED

Fig. 1-5 Ref.	Quantity	Description	Part Number
1	1	1933 SLM to 1935 interconnecting cable	1935-0231
2	1	Head Demagnetizer	1525-0420
3	1	Head Cleaner	1935-0421
4	1	Carrying strap	1935-0436
5	1	Voice Microphone	1935-0420
6	3	30 minute cassette	1935-9603
7	1	1935 to 1933 mast interconnecting cable	1933-9602
8	1	Earphone	1935-9601
9	1	Tool Kits consisting of: 12 cotton swabs 1 Screwdriver 2 Miniature phone plugs	1933-2200
—	5	Alkaline C Cells (not shown)	8410-1500
—	1	Belt Set	1935-0402

Figure 1-5. Type 1935 shown with accessories supplied.

1.5 ACCESSORIES AVAILABLE.

The accessories available for use with the 1935-9701 Cassette Data Recorder are listed in Table 1-6.

Table 1-6
ACCESSORIES AVAILABLE

Name	Description	GR Part No.
Battery	Alkaline energizer C cells Burgess AL1, Eveready E93, Mallory MN1400, or equivalent (5 required).	8410-1500
Type 1940 Power Supply and Charger	Provides for line operation of 1935 and for charging NICAD cells (supplied with Power Supply and Charger).	1940-9701
Type 1933 SLM	Precision Sound-Level Meter	1933-9700 -9701 -9702 -9703
Tripod	Thread (¼—20) mounts to back of 1935.	1560-9590
Cassette	Precision Data Cassette	1935-9603
Patch Cords	Miniature phone plug to double banana plug	1560-9677
	Miniature phone plug to BNC	1560-9679
	Miniature phone plug to standard phone plug	1560-9678
	Miniature phone plug to standard phone jack	1560-9680

1.6 SOUND-ANALYSIS SYSTEM.

The 1935 is available in a complete sound-analysis system that includes the 1933 Precision Sound-Level Meter and Analyzer and many accessories, packaged in a durable traveling case. The case has a foam liner with cutouts to accommodate the components of the system. The 1933-9712 system is supplied with microphones having flat random-incidence response; the 1933-9713 system is supplied with microphones having flat perpendicular-incidence response. The dimensions of the case are (LXWXD) 22-3/16X15-3/8X8-5/8 in. over-all. The systems include the Cassette Recorder, all accessories listed in Table 1-5 for the 1935-9700 and, in addition, the following:

1 —— 1933 Precision Sound-Level Meter and Analyzer with accessories including
1 —— 10-foot microphone extension cable
1 —— Electret-condenser microphone, ½-in.
1 —— 10-dB attenuator for ½-in. microphone
1 —— Electret-condenser microphone; 1-in.
4 —— Batteries (Alkaline "C" cells).
1 —— Carrying and storage case
1 —— Windscreen for 1-in. microphone
1 —— Windscreen for ½-in. microphone
1 —— Dummy microphone, 1560-P9 (35 pF to simulate ½-in. electret-condenser microphone).
1 —— Sound-Level Calibrator, Type 1562, with adaptors for 1-in. and ½-in. microphones, battery and carrying case
1 —— 60-foot microphone extension cable on reel
1 —— Tripod

1.7 POWER SUPPLY AND CHARGER.

The 1940 Power Supply and Charger allows the 1935 Cassette Data Recorder or the 1933 Precision Sound-Level Meter and Analyzer to be operated from the power line independently of its internal batteries, and it also serves as a battery charger. The Power Supply and Charger is supplied with a set of five rechargeable NICAD batteries (four required for 1933, five for 1935) to replace the alkaline C cells.

The recorder plugs directly into the charger, which also serves as a convenient bench stand. When the supply is connected to a power line, the recorder is supplied power from a source independent of the battery, while, simultaneously, the batteries are charged. Alternatively, in the BATTERY mode, the instrument will operate from its batteries while mounted in the charger. Lamps indicate when the charger is connected to an active power line and when the batteries are fully charged. When the battery charge light is on, the batteries are maintained in a fully charged condition by trickel charging. Power to the charger and instrument can be switched by external means in the LINE mode. When power is disconnected, the instrument ceases to operate and does not take power from its own batteries. Refer to paragraph 2.17 for complete operation of the 1940 power supply and charger.

Figure 1-6. Type 1933-9712 or -9713 Sound Analysis System — complete

Operation—Section 2

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2.1 SET-UP AND CALIBRATION WITH 1933.

2.1.1 General.

Before attempting to use the 1935 Cassette Data Recorder with the 1933 Precision Sound-Level Meter and Analyzer, the operator should familiarize himself with the operation of the 1933. Check the batteries in the recorder before following this set-up procedure.

There are two methods of using the Recorder with the Sound-Level Meter. The normal method is to use one sound-level meter recording signal on the A channel of the Recorder and, simultaneously, the encoded level-range information on the B channel. The other method is to use two sound-level meters with each supplying signal (but not range code) to the recorder. For normal use with the 1933 SLM, set the range-code slide switch on the right-side panel to ON and the ON—OFF switch under the front panel dB FULL SCALE display to ON. Set the dB FULL SCALE control on the right-side panel to AUTO.

The 1935 is designed to record and play back the range code signals supplied by the 1933. When the 1933 SOURCE control is set to MIKE B the 1935 *always* interprets the 1933 MAX MIKE dB control as 130 dB. When the 1933 SOURCE control is set to MIKE A, the 1935 may interpret the 1933 MAX MIKE dB control as 130, 140 or 150 dB, depending upon the placement of the pin jack connections on the 1935 main board. The 1935 is set at the factory to interpret the 1933 MAX MIKE dB as 130 dB when the 1933 SOURCE control is set to MIKE A. To change the pin jack connections on the 1935 main-board see para. 4.8.

When the 10-dB attenuator is used with the ½-in. electret-condenser mike on the 1933, the MAX MIKE dB on Channel A is 140 dB. Set the 1935 to interpret this as follows:

a. Set the 1933 SOURCE control to MIKE A.
b. Set the MAX MIKE dB to 140.
c. Place the pin-jack connection on the 1935 main board between points A and B. See para. 4.8.

NOTE

If the 1935 was supplied as part of a 1933 analyzer system, the 1935 pin jacks have been set to operate with the microphones supplied with the 1933.

2.1.2 Connection to Input of Recorder.

Connect the Sound-Level Meter to the Recorder; use the coiled cord (type 1935-0231) supplied. The 9-pin plug mates with the DATA OUT socket on the left-side panel of the 1933 and the 14-pin connector mates with the DATA IN socket on the right-side panel of the 1935. The plugs are keyed; they can be inserted in only one way. On some early models of the 1933, the key way is not present. For these instruments, remove the key from the plug by breaking it or cutting it off with pliers. Because of the arrangement of pins in this plug, it can be inserted in only one way. Fasten the plugs securely at both ends by tightening the thumbscrews.

2.1.3 Recording the Test Signal.

Set the 1933 in its internal calibration mode such that its meter reads at full scale (refer to para. 2.1.1 in the 1933 Instruction Manual). A 1-kHz, 0.5-V signal is then applied to channel A of the 1935 Recorder and is also available at the SIGNAL OUT AC jack on the 1933*. The gain of the record amplifier in the 1935 is adjusted at the factory so that this 0.5-V calibration signal corresponds to the normal maximum record level and the CAL mark on the peak mon-

*On 1933's whose ID is 5658 or higher the level at the AC jack is 0.63 V.

itor panel meters, allowing a minimum crest-factor capacity of 10 dB. The gain should not normally require readjustment.

Press the STOP-EJ key on the Recorder, install a tape, close the cover, and select the record mode by depressing the RECORD and PLAY buttons simultaneously. The CHANNEL A panel meter should indicate at the CAL mark. If it does not, adjust it using the CAL A screwdriver control located under the DATA IN connector on the right-side panel of the Recorder.

2.1.4 Playing Back the Test Signal.

Now, REWIND the tape and select PLAY. The CHANNEL A meter should again indicate at the CAL mark. If the recording is to be played back later into the 1933 for analysis, play back the test signal into the 1933. Use the playback cable 1933-9602 (provided) to connect the CHANNEL A OUTPUT on the 1935 to the mast connector on the 1933. The preamplifier on the 1933 must be removed and replaced by the cable connector. Use a pointed object to depress the latch button protruding through the preamplifier shell. With the sound-level meter SOURCE control set to TAPE and the dB LEVEL control set for the highest level range (i.e. fully clockwise), the 1933 should indicate at full scale.

The 1933 and 1935 are set at the factory so that the recorded CAL tone will indicate full-scale on the 1933 when it is recorded as described in para. 2.1.3. In normal use, this indication will not deviate by more than ±1 dB. If desired, this variation may be compensated for by adjusting the playback gain of the 1935 (Channel A playback control E-R9 (see Figure 1-3)). Turn the control cw if the 1933 indication is below full-scale or ccw if the 1933 indicator above full-scale. When this variation is compensated for by the latter method the 1935 CHANNEL A meter will deviate slightly at the CAL mark (on playback), or by amount equal to the variation. Check that when the test signal from the 1935 is played back, the dB FULL SCALE display on the 1935 indicates the same number of decibels as it indicated at FULL SCALE on the 1933 when the test signal was recorded. Normally (i.e. if the MAX MIKE dB control on the 1933 was set to 130), the dB FULL SCALE display will read 100 dB. Then, when the recording is played back the sound-level meter will read directly in decibels re 20 $\mu N/m^2$.

The above checks should be made frequently, preferably each time the system is used. Adjustment of the record level (CAL A or B) should be unnecessary unless the recorder is used with a sound-level meter having a different serial number or with a different brand of tape. Variations in level over the length of a tape, and from tape to tape, of a few tenths of a decibel are unavoidable and should be expected. This change in level due to the variations from tape to tape can be avoided by recording a calibrate tone at the start of each tape.

NOTE

Errors of shift in recorded level, due to variations in tape and temperature effects on recording, may be reduced or eliminated by recording a calibrate tone at the beginning of each tape.

2.2 RECORDING FROM TWO 1933 SLM's.

2.2.1 General.

It is possible to record the signal from two 1933 Sound-Level Meters on the two channels (A and B) of the 1935-Recorder. Of course, when both channels are used for recording signal, range information cannot be recorded. Set the range code slide switch on the right-side panel of the 1935 to OFF and the slide switch under the dB FULL SCALE display on the front panel to OFF.

2.2.2 Connections to Input of Recorder.

Make shielded connections from the SIGNAL OUT AC jacks on the 1933's to the CHAN A AUX IN and CHAN B AUX IN jacks on the 1935. Shielded cables can be made up using the miniature phone plugs supplied with the 1933, or complete cables can be purchased from an electronics retail store or distributor. One 1933 can be connected to Channel A with the coiled cord (P/N 1935-0231) supplied.

2.2.3 Recording a Reference Signal.

Follow the procedure of 2.1.3, except adjust CAL B as well as CAL A. Turn the B CAL control located under the RANGE CODE slide switch on the right-side panel of the instrument to adjust Channel B for a panel meter indication at the CAL mark.

2.2.4 Playing Back the Test Tape.

Follow the procedure of para. 2.1.4, except check that both CHANNEL A and CHANNEL B meters indicate at the CAL marks on playback. For greatest accuracy, if the recordings are to be played back later into a given 1933 for analysis, play both test signals back into that 1933 and repeat the test recording if necessary, as described in para. 2.1.4, until a full-scale indication is obtained on the 1933.

2.3 USE WITH THE 1933 SOUND-LEVEL METER.

2.3.1 General. (Figure 2-1)

After the 1933 Sound-Level Meter and 1935 Cassette Data Recorder have been set up and calibrated together as described in para. 2.1 or 2.2 above, operation is straightforward. Normally, when one 1933 Sound-Level Meter is used, the slide switch on the right-side panel of the 1935 is set to ON and the dB FULL SCALE control is set to AUTO, allowing the range signal to be recorded on CHANNEL B. The slide switch on the front panel under the FROM SLM – DB FULL SCALE display may be left in the ON position during recording; however, since it always indi-

cates the same number as that which appears in the right-hand FULL SCALE window on the meter of the 1933, it should be turned OFF when recording, to conserve battery life.

The recorder can be hung from its shoulder strap for field measurements while the sound-level meter is hand held. Moving the recorder during recording or playback. may introduce some "wow." Tests have shown that even the most violent motion will not cause sufficient "wow" to effect the result of a spectrum analysis in bands as narrow as one-tenth octave. Spectrum analyzers with bands as narrow as 1% can be used with the 1935 if, when recording, some care is taken to minimize wow. Best results will be obtained if the recorder is placed on a solid vibration free table or stand when recording and playing back for analysis.

2.3.2 Recording.

Select the desired weighting or band of the sound-level meter. To realize the full frequency range of the 1935 Recorder, the Sound-Level Meter should be set to FLAT WEIGHTING. Use the FAST, SLOW or IMPULSE meter characteristic, but not PEAK (IMPACT) (since this duplicates the 1935 meter reading). Turn on the sound-level meter and adjust the dB LEVEL control for a reading in the upper half of the meter scale on the sound-level meter. Press the STOP-EJ button on the recorder and install a tape. Rewind the tape if necessary, then reset the position counter for 000. The original calibration signals can be left on the tape if desired. Now, select the record mode by simultaneously depressing both the RECORD and PLAY keys. Check the CHANNEL A panel meter on the recorder. If the signal being recorded is random or impulsive in nature, the meter reading will vary considerably. If it is a steady periodic signal, the meter reading will be nearly steady. Peaks in the signal should only occasionally, if ever, exceed 0 dB (full scale). If the meter reading is steady and near bottom scale (−15 dB), the full dynamic range of the system is not being utilized. More of the dynamic range can be used by setting the 1933 dB LEVEL control to the next more sensitive range. If this is done, however, when the signal is played back into the 1933 for analysis, some of its components may exceed 0.5 V rms, corresponding to full scale on the meter and it may thus be impossible to read their levels. If it is not planned to use the 1933 for later analysis, it is best to adjust the dB LEVEL control so that peaks on the CHANNEL A meter come as near to full scale (0 dB) as possible, only occasionally exceeding this limit.

When the Recorder is turned on, check that the dB FULL SCALE display indicates the same range as that given by the full-scale window in the 1933. The system is then recording normally.

2.3.3 Playback.

Para. 2.6 covers general playback procedure. Specific details of playing back into the 1933 Sound-Level Meter for analysis are given here, and in para. 2.1.4 where playing back the test signal is discussed. The cable P/N 1933-9602 (supplied) is used to connect the OUTPUT (normally CHANNEL A) of the Recorder to the mast input on the Sound-Level Meter. Remove the preamplifier on the 1933 and install the playback cable, in its socket.

Rewind the tape and use the tape position counter to find the start of the signal on the tape. Set the sound-level meter dB LEVEL control fully clockwise. (If the MAX MIKE dB control is set to 130, 130 will appear in the right-hand meter window). Set the SOURCE control to TAPE and depress the PLAY button. Observe the dB FULL SCALE display on the 1935 and turn the MAX MIKE dB outer knurled control on the left-side panel on the 1933 until the same number is displayed in its right-hand window†. The MAX MIKE dB control must be pressed in before it can be turned. The dB LEVEL control remains in its maximum clockwise position. Now proceed with the analysis just as if it were an analysis of the sound directly. Select the desired octave band or weighting, adjust the dB LEVEL control for an on-scale meter deflection and read the band level in dB re 20 $\mu N/m^2$ from the meter. Bear in mind that the two extreme band levels at 32 Hz and 16 kHz will read somewhat low because of the limitations in the frequency response of the Recorder.

2.4 SET UP AND CALIBRATION WITH OTHER SLM'S.

The 1935 is designed to record, providing full dynamic range, from any sound-level meter that produces an output signal corresponding to full scale, in the range between 0.5 and 3.0 V rms. That is, the Recorder can be set to provide a 0.5-V rms signal on playback for a record signal in this range. Connections should be made to the miniature jacks labelled CHAN A and CHAN B AUX IN. The input impedance on each channel is 100 kΩ.

For normal operation, the signal is recorded on CHANNEL A and the range code on CHANNEL B. Record a test signal derived from the sound-level meter on channel A. It is assumed that this test signal is sinusoidal. If so, then the Recorder's CAL A CONTROL should be adjusted so that the level of the test signal corresponding to full scale on the sound-level meter indicates at the CAL mark on the CHANNEL A panel meter. This CAL mark is 7 dB below the 0 dB overload point. If the test signal is lower than full scale on the sound-level meter, adjust the CAL A control to read approximately the number of decibels below the CAL mark equal to the number of decibels below full scale on the sound-level meter. For example, many sound-level meters, when being calibrated, produce test tones at their output corresponding to 6 dB below full scale on the meter. For these instruments, the CAL A control would be

†Certain early model 1933 SLM's have a stop on the MAX MIKE control that allow 6 range positions. If greater range is required contact the nearest GR Service for modification instruction.

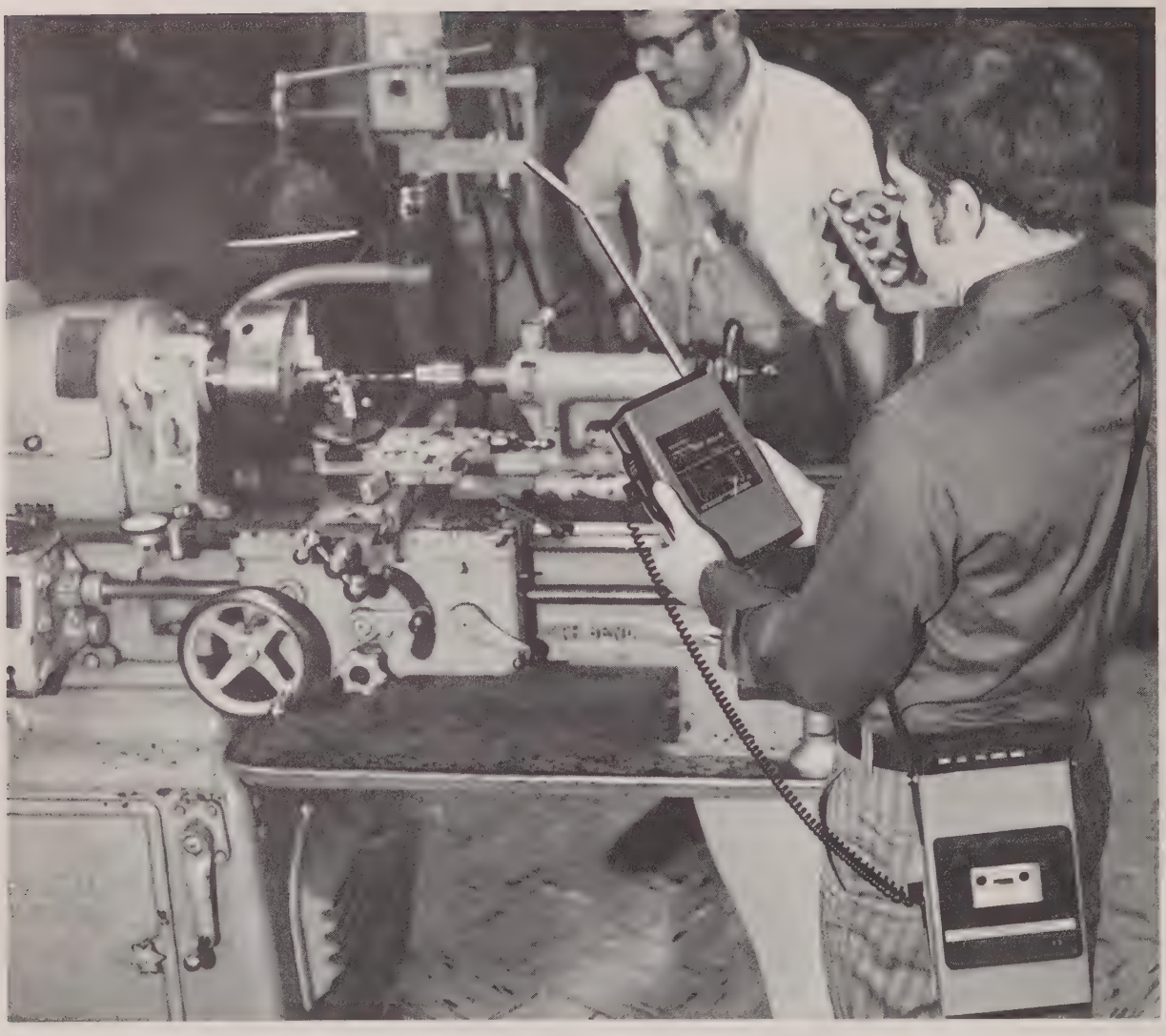


Figure 2-1. Use of the 1935 Recorder with the 1933 SLM.

adjusted so the CHANNEL A meter indicates about (−7 −6) = −13 dB below the 0 dB mark. The playback level corresponding to full scale on that sound-level meter would then be 0.5 V rms with a crest-factor allowance at full scale of 10 dB. It is possible to make the output voltage on playback exactly 0.5 V corresponding to full scale on a given sound-level meter by measuring the output voltage from the Recorder with a voltmeter, then recording it again after adjusting the CAL A control slightly up or down depending on the level until the exact value is found. If the test signal corresponds to a level 6 dB below full scale and not to full scale, the level of the output test signal should be set to be 0.25 V. An alternate procedure is to use an acoustic calibrator with SLM and adjust its gain to some full-scale indication. Adjust the 1935 channel A gain for a CAL reading. Then reset the SLM gain for the correct SLM reading.

2.5 RECORDING FROM OTHER SLM'S.

It is best to preserve some of the test signal recorded using the procedure of paragraph 2.4, although in principle this is unnecessary. The "full scale" or other reference level can be taken from the tape, or it can be recognized that a 0.5-V playback level corresponds to full scale on any range of the sound-level meter.

Range code is recorded on Channel B by setting the CHANNEL B slide switch on the right-side panel to ON and then setting the dB FULL SCALE control to the range

being used on the sound-level meter as the recording is made. This setting need not correspond to a full-scale indication on the sound-level meter. In fact, on many sound-level meters, the marking on the level range control corresponds not to full scale but to a level 10 dB below full scale. For these instruments, it is logical to record, on channel B, the setting of the level range control..

2.6 PLAYBACK.

2.6.1 Outputs.

The signal available from both channels A and B of the 1935 on playback has a level of 0.5 V rms corresponding to the normal maximum record level. When the Recorder is set up for use with the 1933, the normal maximum record level is 0.5 V rms, and this level corresponds to full scale on the meter of the 1933. The normal maximum record level is an rms level 10 dB lower than the peak signal level corresponding to overload so there will be no significant distortion or clipping of the signal whose crest factor is 10 dB or less. The peak signal voltage at the OUTPUTS can be as high as 3.16 X 0.5 = 1.58 V. The output impedance of the recorder is 600 Ω for each channel. Outputs can be terminated in any impedance.

2.6.2 Use of Output Signal.

The outputs can be used to supply signal to the 1933 Sound-Level Meter or to level recorders, headphones and spectrum analyzers. No special precautions need be taken except when the recorder is used to supply a narrow-band spectrum analyzer. Then, the effect of wow and flutter produced by the tape recorder must be understood.

2.6.3 Playing Back Into Narrow-Band Spectrum Analyzers.

The 1935 is intended for use with spectrum analyzers. When it is used with analyzers where the percentage bandwidth at any frequency is 2% or less, the effect of wow and flutter should be considered. If the recording has been made with the Recorder held still or placed on a solid vibration-free table, there should be no significant effect even with bandwidths narrower than 2%, providing, of course, that the Recorder is held still during playback.

If, on the other hand, the recorder was handled roughly during recording, wow and flutter of as much as one percent or more may have been generated. Wow and flutter are variations in frequency of the recorded signal introduced because of tape speed variation and other effects. In the spectrum of a recorded signal, the wow and flutter will show up as additional frequency components very near to the original frequency components, which will be apparent if the spectrum analyzer has sufficiently narrow bandwidth. It is recommended that the Recorder be handled carefully during recording and playback when a narrow-band constant-percentage or constant-bandwidth wave analyzer is being used.

2.6.4 Controls and Panel Meter Interpretation on Playback.

Depress the PLAY key to playback a signal recorded on the tape. Depress the STOP-EJ key slightly to stop playback. To eject the tape cartridge once it has stopped, release the STOP-EJ key and then depress it hard.

The PAUSE CONTROL is useful on playback, as during recording, to prevent an electrical transient signal from interfering when the tape is started or stopped. When starting a tape, depress the PAUSE key before the PLAY key. Then, to start the tape, press the PAUSE key and release it. When stopping the tape, first depress the PAUSE key and then the STOP-EJ key.

The panel meters operate on playback to display the peak level of the recorded signal. Full scale (0 dB) corresponds to the overload or saturation level, and the CAL mark corresponds to a peak level 7 dB below saturation. This is the peak level of a 0.5-V rms sine-wave signal (the calibration signal applied by the 1933) provided at the OUTPUT on playback. The recording should be considered of good quality, if, on playback, the meters deflect well up-scale but only occasionally exceed the full-scale (0 dB) level.

2.7 HANDLING AND CARE OF TAPES.

The compact cassette has several distinct advantages over the reel-to-reel recorder. Since the tape is enclosed in the cassette, the tape is not exposed to dirt and grease, which would impair the performance of the tape. Furthermore, since the tape itself is not handled, there is little possibility of tape deformation.

Certain precautions should be taken to insure consistent quality of recording and playback:

1. Always store the cassette in the plastic container when the tape is not used.
2. Store recorded tapes in a place not subject to extremes of temperature and humidity.
3. Do not place recorded tapes near magnetic fields. The quality and accuracy of the recording is a direct function of the magnetic flux on the tape. External fields may shift or erase the tape.

> CAUTION
>
> The permanent magnet that is part of the panel meter on the sound-level meter in use will produce a stray magnetic field that can erase the tape if it comes in contact with the meter face.

4. Periodically demagnetize the tape heads. This will prevent tapes from being partially erased when they are played. Para. 4.4 describes the demagnetizing procedure.
5. If, occasionally, a cassette jams during fast-forward or fast-rewind, it may be cleared by rapping the flat side of the cassette sharply on a hard surface. Jamming usually occurs in a much-used cartridge. Cassettes do not have indefinite life and such tapes should be retired.

6. Repeated playback of a recorded tape will tend to erase some of the flux on the tape, especially at high frequencies. Chromium dioxide tape is superior to ferric oxide tape in this respect. (Refer to para. 2.8 for information regarding tape selection).

7. To prevent accidental erasure, uncover the left record sense hole on the cassette.

8. Cassettes which contain a foam pressure pad in the ERASE window must not be turned over or the capstan shaft may damage the foam pad. The tape cassettes supplied by GR include this pad.

9. Since the 1935 recorder utilizes the full width of the tape while recording in one direction, do not turn the cassette over as in conventional entertainment cassette recorders.

10. The cassettes supplied with the 1935 have a plastic leader which consumes about 10 s of playing time. During record set-up, the operator must allow for this 'dead time', since no recording will be made on the leader.

2.8 CHOICE OF TAPES.

2.8.1 General.

The performance of the recorder is a joint product of the magnetic tape and electronic circuitry. It cannot be emphasized enough that the characteristic of the tape type influences the performance of the recorder. Consequently, if ultimate performance is to be realized, the correct tape must be used. Due to the nature of tape manufacturing, it is impossible to maintain absolute uniformity from lot to lot. It is even more difficult to obtain uniformity from different makers of the same basic tape type. Variation in plastic backing and magnetic coating thickness, as well as magnetic material, greatly influence record/playback level, high-frequency response, distortion, and noise levels. Variations from one tape type to another (not cassette-to-cassette) may require readjustment of bias for proper operation.

2.8.2 Chromium Dioxide Type (Crolyn®).

Compared to standard ferric-oxide tapes, chromium dioxide tapes possess several distinct advantages. They tend to be more uniform lot-to-lot and maker-to-maker, so that frequency recalibration of the instrument is unnecessary. Also, they possess a "harder" magnetic characteristic, such that while more difficult to record with, they retain recorded flux better, which is important for noise analysis. The particle structure of chromium dioxide allows higher frequency performance than ferric-oxide tapes, and so possesses a better overload characteristic at higher frequencies. Thus, Crolyn® tape was selected as the standard tape for the 1935 Data Recorder. Among other features, Crolyn® tapes can record up to 6 dB higher levels at 10 kHz than can ferric oxide tapes for a given overload level.*

It must be realized that the mechanical package for the tape is as important as the tape. Certain cassettes are prone to jamming, due to poor windup and static charge buildup.

Additionally, to insure consistent erasure, the tape-cassette supplied by General Radio is provided with a foam pressure pad in the ERASE window.

For the above reasons it is recommended that the operator of the 1935 Data Recorder use the tape supplied by GR (P/N 1935-9603).

®Registered DuPont trade name.

* For a discussion of the characteristics of chromium-dioxide tapes, refer to
"Audio Cassette Chromium Dioxide Tapes", Naumann and Daniel, *JAES* Nov. 1971, Vol 19, No. 10, pp. 822-828.
"Chromium Dioxide Audio Cassette Tape", Jordon, Kerr, and Dirkens, *JAFS*, Jan/Feb 1972, Vol 20, No. 1, pp. 2-6.
"Chromium Dioxide vs. Ferric Oxide Cassette Tapes", Julian Hirsch, *Popular Electronics*, June 1971, pp. 50-53.

2.9 USE OF VOICE-INTERRUPT MICROPHONE.

2.9.1 General.

The hand-held voice microphone (supplied) provides the capability of recording useful auxiliary information concerning the Channel A recorded data. This voice mike obviates the necessity of making hand-written notes concerning such things as the weather, time, data channel, mike location, and other important ambient recording conditions.

The voice mike uses range-code channel B. When the voice microphone is used, the range code is disabled. When the tape is played back, the user can hear the voice notes at channel-B output, using the earphone supplied.

The voice mike is automatically leveled with about 40-dB range, attack time is approximately 1 ms, and release time of approximately 1 s. The voice microphone is also weighted against low frequencies. It is not suited for music recording.

2.9.2 Using the Voice Microphone.

Set the recorder up in the usual manner, as described in para. 2.3.2. In addition:

a. Set the range code switch to ON.

b. Insert the voice mike (supplied) in the VOICE INTERRUPT terminals next to the range code switch.

c. Set the dB FULL SCALE control to AUTO for recording from the 1933 SLM, or to the manual setting desired.

d. Proceed to record.

e. To record voice notes, press the spring-return switch on the voice microphone. Talk at a normal level, 6 to 12 in. from the microphone. Release the switch to resume range-code recording.

f. During playback, listen to the voice notes on Channel B output with the earphone supplied. The tones for the range code will be heard except during voice-note playback.

NOTE

Occasionally, the dB FULL SCALE display will flash on during voice-note playback, a normal condition.

2.10 CHANNEL A AND B INPUT AND OUTPUT JACKS.

2.10.1 General.

Normal connection to and from the 1935 is by subminiature phone connectors. In addition to the 1933 to 1935 interconnecting cable, the 1935 to 1933 mast cable, and earphone, all supplied, the user may prepare cables with miniature coaxial cable and the 2 subminiature connectors supplied. Other interconnecting cables are available (refer to Table 1-6).

2.10.2 Inputs.

The 1935 is intended for use with high-level signal sources such as SLM's, analyzers, signal sources and so on.

CHANNEL A AUXILIARY INPUT is wired in parallel with the DATA IN connection on the multiple-pin connector, and is open circuited. Only one input should be made to CHANNEL A INPUT or there may be signal interference.

CHANNEL B AUXILIARY INPUT is shorted to ground in the absence of input connection.

Electrical characteristics for both channels are the same. The inputs are capacitively coupled, with 50 Vdc maximum allowed, approximately 100-kΩ load resistance. The inputs should be driven from a low source impedance of less than 1 kΩ. Permissible input signal range is 0.5 to 3 V rms for proper calibration.

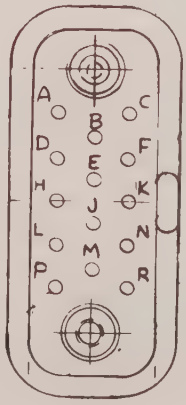
2.10.3 Outputs.

Channel A and Channel B outputs are electrically identical. These jacks allow the 1935 to be used as a source for voltmeters, analyzers, graphic level recorders or other such devices. They may also be used to drive earphones. The rms value of the output (open-circuit) voltage corresponding to a normal maximum recorded level is 0.5 V. The source impedance is 600 Ω. Any load can be connected without affecting the linear operation of output circuits or meter readings.

2.11 DATA INPUT/OUTPUT CONNECTOR.

2.11.1 Inputs.

The DATA IN connector takes inputs from the 1933 via patch cord P/N 1935-0231. The layout of the connector is shown in Fig. 2-2. Pins A, D, H, and L correspond to logic lines 1,2, 4 and 8, respectively. Coding is binary with a contact closure to ground representing true. The 1935 normally receives code numbers 3 to 13, representing 30 to 130 dB. Pin B receives code from the 1933 SLM, which will add 10 to the normal 30 to 130 dB display, when the 1933 SOURCE control is set to MIKE A and an internal jumper is connected from points A and B (main board) or add 20 dB when the jumper is connected from A to C (main board).



PIN	FUNCTION
A	LOGIC 1 IN
D	LOGIC 2 IN
H	LOGIC 4 IN
L	LOGIC 8 IN
B	'ADD LOGIC'
E	'REMOTE'
J	SHIELD
M	CIRCUIT GROUND
P	SLM IN
R	TAPE OUT
C	LOGIC 1 OUT
F	LOGIC 2 OUT
K	LOGIC 4 OUT
N	LOGIC 8 OUT

Figure 2-2. Data In Connector.

Lines A, D, H, and L are pulled up to +9 V. At no time should they be connected to a potential greater than +9 V. Sinking current for a logical true (closure to ground) is approximately 45 μA.

Pin B is pulled high (+9 V) through 200 kΩ when a jumper is between pin jacks A and B or A and C on the 1935 main-board. Otherwise, it is an open circuit. To program the ADD function, a potential between −5 and −9 Vdc must be applied. The sinking current is approximately 45 μA.

The ground return for all logic connections is at pin M.

The range code lines A, D, H, and L are in parallel with the manual dB FULL SCALE switch. Consequently, valid encoding from the 1933 SLM will occur only when the dB FULL SCALE switch is set to AUTO.

CAUTION

Do not operate the manual dB FULL SCALE control if 1933 is connected to the DATA IN connector. A faulty range code may be recorded on the tape.

Pins P, M and J are used to connect the AC SLM OUT signal from the 1933 to the 1935. Pin P is the signal high, pin M is the circuit ground, and pin J is the shield. Pin P is in parallel with CHAN A AUX IN, so that only one connection should be used at a time. Input impedance is approximately 100 kΩ.

2.11.2 Outputs.

Pins C, F, K and N correspond to logic lines 1, 2, 4 and 8, respectively, for range-code output. Coding is binary, with a true at a voltage between +5.5 and +7 V dc (depending on battery condition). The output impedance is about 100 kΩ. Output code range is 3 to 15, representing 30 to 150 dB.

Outputs can also be taken from the DATA IN connector and used to prescale an analyzer or computer. They may also be used to 'key' an analysis start and stop points. Approximately 0.5 s settling time may be required after a range-code change for a valid test of the range code.

Pins R, M and J are used as tape output (CHANNEL A), circuit ground and chassis, respectively. Output impedance is approximately 600 Ω with 0.5 V rms at normal maximum recorded level. Any load is permitted. No connection on the 14-pin connector is provided for CHANNEL B tape output.

2.11.3 Remote.

Pin E is used in either the record or playback mode for 'remote' turn-off of the recorder. A contact closure to ground at pin E will shut down the motor transport and electronics of the tape recorder. Idling current from the battery at shut down is approximately 1 mA. Shut-down sinking current is approximately 300 μA. Turn-on time for the transport is approximately 400 ms.

Extended periods of shut down of the deck may cause a bump in the capstan pinch wheel, causing some increase in flutter. If a noticeable flutter is encountered that is not smoothed out by an hour or so of playing, the capstan pinch wheel should be replaced.

2.12 CHECKING AND CHANGING BATTERIES.

The batteries should always be checked before using the recorder. The batteries are most heavily loaded when the recorder is in its RECORD mode with the panel dB FULL scale display turned ON and it is best to test the batteries under this condition.

To check batteries, set the slide switch under the CHANNEL B panel meter to BAT CHECK. With the recorder in an operate mode, the meter should now indicate above the BAT mark. If it does not, stop the instrument, slide off the battery cover on the bottom panel and replace the batteries, being careful to observe polarity. Use alkaline energizer "C" cells (5 required) Burgess AL1, Eveready E93, Mallory MN1400 or equivalent. Alkaline energizers will provide about 10 hours continuous operation. Ordinary flashlight batteries can also be used but the operating time will be substantially less.

2.13 DYNAMIC RANGE AND NOISE.

Table 2-1 presents the noise level of the 1935 as read on the 1933 octave bands when measured on the 'TAPE' input.

Figure 2-3 shows the dynamic range of the 1935 with the Crolyn® tape supplied. The upper reference is the 3% harmonic-distortion point at 1 kHz, which is the full-scale level. The upper line is the 1-dB compression point, which is a function of the recording overload characteristic of the tape, and is frequency sensitive. Since the 1935 meter circuits sample the equalized record signals, overload at

Table 2-1

TAPE NOISE LEVELS

Octave-Band Center Frequency	1933 dB Reading*
32 Hz	66
63 Hz	72
128 Hz	69
250 Hz	70
500 Hz	60
1 kHz	65
2 kHz	65
4 kHz	67
8 kHz	70
16 kHz	75

*Normal maximum level = 130 dB on 1933, full scale = 137 dB. Subtract noise reading from 137 dB for S/N. Reading may vary ±3 dB depending on playback gain. Tests made with head demagnetized and tape still.

frequency extremes is avoided where the record signal is peaked. The operator is forced to change the SLM level-range control to a less sensitive range, if high peak signals are present in the extreme frequency ranges.

The lower level in Figure 2-3 represents the 1/3-octave noise level measured on the 1523 level recorder and -P3 1/3 octave plug-in analyzer. The noise level is a function of the tape noise and electronic playback circuit noise.

2.14 TAPE ERASURE.

It is important in any recording noise analysis system that the tape be free of any previously recorded signals. The 1935 Data Recorder contains a system that erases the tape 50 dB or more. It must be noted, however, that good erasure is dependent on many factors, such as good head-tape contact, head alignment, proper bias adjustment and use of tape free of surface imperfection.

Narrow-band analyses requiring more than 50 dB S/N may demand greater tape erasure. Also, tapes saturated with high signal levels are harder to erase than lower signal levels. Finally, that characteristic which makes chromium-dioxide tape excellent for signal preservation, high magnetic retentivity, also makes this tape harder to erase.

As a result of these points, if the 1935 user makes repeated use of a single tape for narrow-band analysis (or if the user has more than one 1935 for which tapes may be interchanged), it is recommended that the tapes be erased on a bulk demagnetizer before each recording session.* Use of a bulk demagnetizer is good general practice, providing the best performance from prerecorded tapes. Alternatively, the user can erase the tapes in the 1935 by recording the tape from end to end *without* applying signals to channels A and B. This method will provide erasure ⩾ 50 dB.

2.15 EFFECTS OF TEMPERATURE ON PERFORMANCE.

The 1935 Data Recorder has been designed for use at a wide range of environmental conditions. The electronic circuits are designed with a wide margin such that gain shifts are negligible. The bias circuits, an area often overlooked, have been stabilized and temperature compensated such that the bias does not appreciably influence response over a wide temperature range.

The most pronounced degradation of performance will occur at temperatures below 10°C, where the tape and tape-drive-chain elements become stiffer and, therefore, harder to drive. As a result, the drive speed will be reduced, resulting in a shift to higher frequencies during playback at room temperatures. If low temperature operation is anticipated, take the following precautions:

1. Use fresh batteries. Low temperature reduces battery capacity, and increases 1935 current drain, due to motor-drive requirements. Check the batteries often.

2. Avoid condensation due to change in temperature, especially in the cassette, which will cause the cassette to jam. Do not use nonpreferred cassettes.

*Bulk erasers, such as those manufactured by Nortronics Company and Robbins, are available from many electronics distributors.

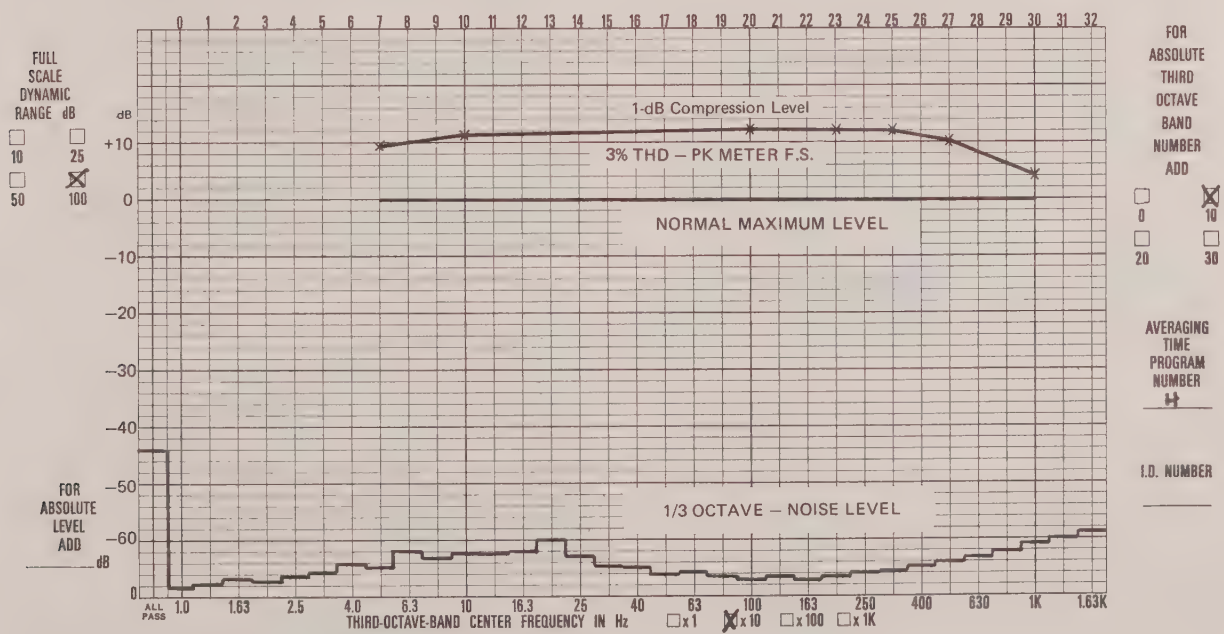


Figure 2-3. Typical 1935 dynamic range recorded on GR1523.

3. Record a test tone on the tape as a frequency that can be detected later to determine the degree, if any, of speed reduction.

2.16 USE OF ACCESSORIES. (Figure 1-5)

A number of accessories are supplied with the 1935 Cassette Data Recorder. The purpose of each is described in the following paragraphs:

The Head Demagnitizer (P/N 1525-0420) is used for demagnetizing the record/playback head. It should be used frequently to minimize noise and distortion that results when the head becomes magnetized. See para 4.4.1 for procedure.

The Head Cleaner (P/N 1935-0421) and swabs are used to clean the record/playback and erase heads. See para 4.4.1 for procedure.

CAUTION

Other head cleaners could damage head surfaces.

The Cable Adaptor Assembly (P/N 1935-9602) has a miniature phone plug on one end and a connector that mates with the mast input connector on the 1933 Sound-Level Meter on the other. It is supplied with the 1935 Cassette Data Recorder and is intended to be used in playing back recorded signals into the 1933 for weighting or octave-band analysis. This cable can also be used to connect the 1560-P62 Power Supply to the input of the 1933, thus allowing the 1560-P42 Preamplifier to be substituted for the 1933 Preamplifier. The 1560-P42 is used for driving very long cables.

The mine label (P/N 1935-0110) is a self-adhesive label stating that the 1935 has been safety approved for use by the U. S. Bureau of Mines. It should be attached to the instrument as instructed in the protective folder by those who intend to use the recorder where Bureau of Mines approval is required.

The coiled cable assembly (P/N 1935-9630) is intended for use in recording from the 1933 Sound-Level Meter. All necessary recording connections between these instruments are made through this cable. This includes signal and range-code connections from the 1933 to the 1935.

The capstan drive belt set (P/N 1935-0402) is a replacement set. See paragraph 4.7 for information on changing belts.

The earphone (P/N 1935-9601) supplied with the 1935 is used to monitor the CHANNEL A or B OUTPUT during playback.

The microphone (P/N 1935-0420) is intended for recording voice notes. It is plugged into the jacks on the right-side panel and, with the RANGE CODE slide switch set to ON, permits notes to be recorded on CHANNEL B. The input from the microphone is fed through an automatic-level-control circuit so that the signal recorded is to some degree independent of the voice level at the microphone.

The cassette (P/N 1935-9603) supplied, contains chromium dioxide tape. It normally is run in one direction only and is filled in 30 minutes. The cassette contains a foam pressure pad in the ERASE window. Do not turn cassette over as the capstan shaft will damage this pad.

2.17 1940 POWER SUPPLY AND CHARGER.

2.17.1 General.

The 1940 Power Supply and Charger permits the 1935 to be operated directly from the power line and also permits use of rechargeable batteries. The 1940 is supplied with rechargeable batteries that are used to replace the alkaline energizers supplied with the 1935.

2.17.2 Initial Installation.

Before plugging the 1940 into the power line, set the line switch on the bottom of the instrument to the proper voltage setting.

2.17.3 Instrument Installation.

The 1940 will supply power for operating and battery charging to either the 1933 Precision Sound-Level Meter or 1935 Cassette Data Recorder. No adjustments in the 1940 are required to operate either instrument.

Before connecting the 1940 to the instrument to be powered, replace the ordinary "C" cells in the instrument with the rechargeable nickel-cadmium cells supplied with the 1940.

Five recessed jacks on the bottom of the 1935 accept the plugs on the 1940. Simply plug the instruments together. The 1940 Power Supply and Charger also serves as a convenient bench stand. Dimensions for the 1940 are shown in Figure 2-4. See also Appendix A.

CAUTION

Be sure the powered instrument is pressed firmly against the plug base of the 1940 to insure proper activation of the battery switch in the battery compartment. Failure to do so will result in improper charging.

2.17.4 Battery Charging.

The 1940 Power Supply and Charger is designed to operate with sealed nickel-cadmium 2-Ah "C" cells. Variations in cell construction make it imperative that only the type battery supplied with the 1940 be used or the trickle charge circuit may not function properly. Under no circumstances should the 1940 be used with ordinary "C" cells. Remove these cells before powering with the 1940.

WARNING

Do not use the 1940 with Alkaline "energizers" in the 1935 or 1933. These cells may explode when charged.

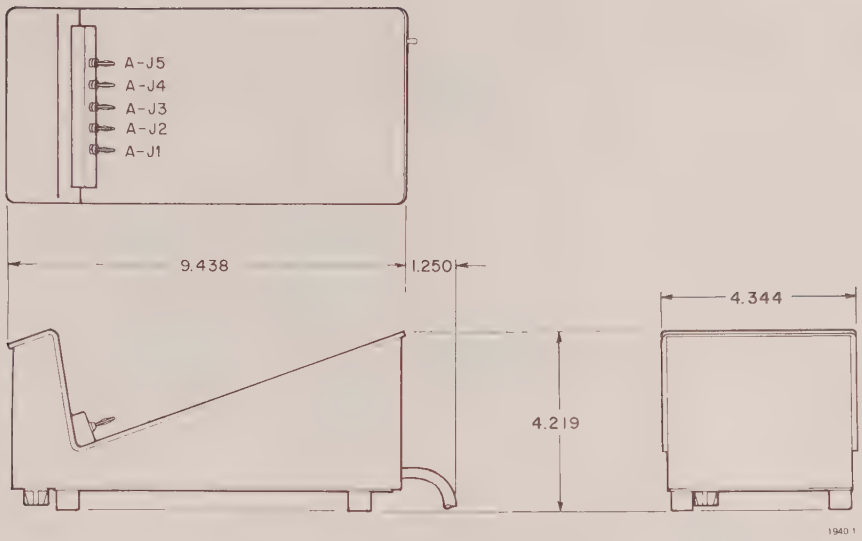


Figure 2-4. Type 1940 Power Supply and Charger.

Whenever the 1940 is plugged into the power line, the batteries in the powered instrument are charged by an independent regulator in the 1940, *regardless of the BATTERY/LINE POWER switch position,* or the setting of the powered instrument on/off switch.

When the batteries are fully charged in the powered instrument, the charge reduces to a trickle and the BATTERY CHARGED lamp lights. Normal charge time is 14 to 16 hours from discharged state.

Care should be taken not to allow the batteries to discharge completely, since "cell reversal" may occur in one or more cells. If deep discharge occurs, test the individual cells with a voltmeter to see the presence of residual charge. Discard any dead cells.

If the operating instrument is under constant charge for long periods (many weeks), it is desirable to discharge the cells occasionally so that they will maintain their capacity.

2.17.5 Line Operation.

To power an instrument from the 1940 supply, connect the 1940 power cord to a power line and set the BATTERY/PWR LINE switch to PWR LINE. The PWR LINE lamp will light. The instrument under power will operate in the normal way, operating from an independent regulator in the 1940. Removing power from the 1940 line will also remove power from the operating instrument, and the batteries will not be discharged. Consequently, PWR LINE operation allows remote powering of an instrument.

PWR LINE operation also allows powering of an instrument that has its batteries removed.

2.17.6 Battery Operation.

In the BATTERY mode, the instrument batteries are connected to the instrument in the normal manner, except that they are being charged by the 1940.

In this mode, the batteries may reduce the effects of line transients, acting as a large filter.

Remove the 1940 power cord from the line to completely isolate the system from the AC line. In the BATTERY mode, removing the power from the line cord will allow the batteries to discharge, if the operating instrument is left on.

Theory–Section 3

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3.1 GENERAL.

The 1935 Recorder uses a cassette deck that has been modified, incorporating an improved motor-speed control and precision head assembly. Refer to Fig. 5-3 for the block diagram and circuit flow of the recorder. Note that parts are identified by a prefix letter designating their sub-assembly letter. Parts with 'A' prefix identify chassis parts and assemblies. Interior views in Section 4 show relative positions of these elements and board assemblies. Details of main board 'B' are shown in Fig. 5-6. This large board includes the power supply, record amplifiers, signal and data inputs, bias oscillator, peak detectors and meter amplifiers, and range code circuitry.

Readout board 'C', which lies below the front readout bezel, contains the meters, end-of-tape indicator, digital driver and readout (Figure 5-8). Motor-speed-control board 'D', shown in Fig. 5-10, is on the top of the deck, surrounding the motor.

Preamplifier board 'E' is shown in Fig. 5-5. It is located below the head assembly on the underside of the deck. The board includes the two playback amplifiers and the record/playback control switch. Board 'F', in the top of the chassis near the head assembly, contains the bias-oscillator traps and bias-current controls. The Signal Table in para 4.11 details wiring interconnection in the instrument.

3.2 POWER SUPPLY (MAIN BOARD, B).

The majority of the recorder circuitry is supplied by ±9 V, (Figure 5-9) derived from a free-running oscillator composed of Q20 and Q21, and associated regulator Q22-Q25. The square pulses at the output of transformer T2 are applied to a rectifier/filter circuit that provides ±9 volts at its output. The frequency of oscillation is between 200 and 300 kHz, well above the audio band, minimizing interference with recorder signals. The output of the negative side at the supply is sampled through 9-V Zener diode, CR24, and is presented to the base of transistor Q23. This transistor is initially held on by R132, connected to the battery side of the power supply. This condition turns transistor Q24 on, supplying base current to Q22. Q22 behaves as a variable resistor, analagous to the series-pass transistor in a conventional power supply, and adjusts the amplitude of the signal presented to the transformer primary. As the output of the minus supply exceeds 9 V, transistor Q23 is turned off, which turns off Q24 and starves the base current of Q22. At –9 V, there is an equilibrium condition.

Q25, connected to the emitter-base of Q24, is incorporated to shut down the power under the following conditions. (1) When the "end-of-tape" sensor has been activated (see para. 3.6), (2) When a ground closure is applied to pin E of the DATA INPUT connector (B-S01) to allow remote operation of the 1935 and, (3) when using either the FAST FORWARD or REWIND mode (only motor-drive transistor is on). This saves power for non-operate modes. The normal primary current drain is approximately 150 mA with the instrument in the "playback" mode and with the readout off. This drain increases to about 175 mA in the "record" mode. The current with the readout on, is a function of the particular digits being indicated, with a maximum total near 225 mA in the record mode.

3.3 RECORD CIRCUITS (BOARDS B, AND F) (Figure 5-7)

The circuitry of the main board, B, is illustrated in on two schematics (Figure 5-7). Its description follows:

Two identical record amplifiers and head drivers comprise the record circuitry. These current amplifiers are identical when the 1935 is setup to be driven from two sound-level meters. Consider Channel A components; Channel B components are shown in parens, i.e. (- - -). A signal (0.5 to 3 V rms maximum record level) from a sound-level meter, is presented to operational amplifier, U2 (U3), via gain control pot, R10 (R6). U2 (U3) is a noninverting amplifier that provides the pre-emphasis required to obtain flat overall record/playback response. This pre-emphasis technique

yields increased signal-to-noise ratio and is required for flat over-all response when the standard playback curve is utilized. The pre-emphasis curve shown in Fig. 4-6 has two features. The sharp peak response at approximately 15-17 kHz is produced by the circuit consisting of L1 (L2) and C7 (C17) with R13 (R27), to stabilize the Q of the circuit. The gradual low-frequency emphasis is produced by C8 (C18), R15 (R29), and R14 (R28). The gain of this stage is approximately 14 dB at 1 kHz. The output level at this stage is 0.5 V rms for normal maximum record level. This level, which is presented to the meter circuits, is identical to that which a playback amplifier provides, so that a unity-gain system will yield identical indicator readings for both recording and playback at 1 kHz.

Tape-recorder heads must be driven from a constant-current source to obtain the desired record/playback characteristics. In the 1935, true current sources are used to drive the head. Transistors Q5 (Q7) and Q6 (Q8) perform the function of a current source and a current sink for a direct current. Variations in the current due to the modulating signal are presented to the head. Channel A head bias current level can be adjusted by F-R1, channel B by F-R2.

Calibration of the head record current is made by adjusting potentiometer R17 (R31) at the input of the current amplifier, measured at E-R14 (E-R15) (on the playback board 'E'), which is in the return path of the head.

Since the output impedance of the head-drive circuit is very high, distortion will occur if the bias voltage presented to the head is not trapped. Bias traps F-L1 (L2) and F-C3 (C-4) found on Board 'F', resonate at the bias-oscillator frequency to prevent this distortion.

Channel B also serves the function of microphone amplifier and code-record channel.

Operational amplifier U1 is a high-gain, automatic-gain-controlled stage for the microphone, with a FET control element. The control for the field-effect transistor is derived from the peak detector at the output of the Channel B meter detector amplifier. The time constants for this circuit are set by the detection circuit, to be approximately 10-ms rise and 1-s decay. The control range of the stage is about 40 dB, with the onset of limiting somewhere in the vicinity of 70 dB sound-pressure level. At the hand-held microphone, the switch on the microphone will select either the microphone signal or the code signal by programming U18. Two gates of U18 form logic control, while the remaining two gates are analog switches for the mike signal and range-code analog signal.

3.4 BIAS OSCILLATOR (BOARD, B).

The bias oscillator is a free-running multivibrator with transformer feedback. Transistors Q9 and Q10 are alternately turned on and off, injecting square pulses of current into the load. The tuned circuit, consisting of C32 and the erase head, reduce the distortion of the switching circuit to less than 1%. The voltage across the erase head is approximately 100 V peak-to-peak, producing 40 mA total current in the erase head. The circuit composed of C13, CR34, R137, C15, R24 and Q26 form a detector, filter and level-control circuit to maintain a constant-voltage drive to the erase head and record-bias circuits.

3.5 METER CIRCUITS (MAIN BOARD, B) (Figure 5-7)

Two meter circuits are incorporated, one for each channel. Inputs are gated by U8, from either the record or the playback lines, by control signals generated by the switch (E-S1) on the playback board. These signals are then attenuated and routed to the hybrid-peak detector amplifier, U4 and U5. Each peak-detector amplifier provides a negative-going full-wave rectified signal at its output. Peak detection is accomplished via a diode and a long-time-constant filter (2.5 s). Unity-gain buffer amplifiers, U6 and U7, drive the meters to the proper level. B-R135 and 136 adjust meter deflection. The output from the peak-detector amplifier of Channel B also supplies signal for the mike AGC circuit. Channel B meter is also used to check the battery. The switch for this is located on the indicator board (Board 'C').

3.6 CODE CIRCUITS (MAIN BOARD, B, AND READOUT BOARD 'C') (Figures 5-7 and 5-9)

The range code input from the 1933 Sound-Level Meter has a binary format. See Figure 2-2. It consists of a contact closure to ground for a true input. When the 1933 Sound-Level Meter is used with the 1935, dB FULL SCALE switch B-S2 is set to the AUTO position. This position is, in reality, the binary 0 setting, so that the 1933 input code is superimposed over the binary 0. If the 1933 is not used, the code can be set manually with switch B-S2. In the event that the 1933 is connected to the 1935, and the switch is set to some indication other than AUTO, the net result will be an erroneous code.

In addition to the range-code inputs from the 1933 or the manual code switch, there is one further input derived from the 1933 called the "add code".

Its function is to change the scale factor of the coding to correspond to full-scale settings of 130, 140 or 150 dB in the 1933 SLM. The ADD function is enabled *only* when the 1933 SOURCE switch is in the MIKE A position. The amount to be added depends on pin-jack connections on the 1935 main-board (see para. 4.8 and Figure 3-1.) The logic levels for the ADD line are different than those for the range code. The ADD line is normally pulled high (+9 V) through either R67 or R144 (200 K). To program the ADD function, a potential between −5 V and −9 V must be applied. R68 (200 K) limits the current and CR5 clamps the voltage to ground to insure compatibility with U9 the binary adder. The addition of the two binary numbers from the range code and the "add line" is performed by a four-bit binary adder, U9. The outputs from U9 are used to gate one or all of four oscillators that produce tones correspond-

ing to the binary coding. The oscillators operate in the following manner:

U10, which is representative of the four oscillators, U10 to U13, consists of a bridge-T circuit in the negative-feedback loop, to set the amplifier gain to approximately 40 dB at the center frequency of the filter. The positive feedback loop has an attenuator from the output to the input that is nearly 40 dB. If a logic control line, such as the binary 1 line, at the input of U9 is +9 V, meaning "logic 0", U9 binary 1 output is high. A diode (CR-6) connected to the positive feedback of the filter amplifier conducts, thereby loading the network, which prevents oscillation. In the "logic 1 true" mode, the output from U9 is low (at ground potential). The diode connected to the positive feedback loop of the filter oscillator does not conduct. This allows the stage to oscillate. U17 acts as a gate, and is open during the record mode. In the playback mode, U17 connects a low source impedance, R119, to the positive feedback networks so the oscillation is prevented.

The oscillation frequency is controlled by the ratio of the components in the negative-feedback loop. The amplitude of the oscillation is controlled by the soft-limiting device consisting of a silicon diode and the emitter/base junction of a silicon transistor Q11 (Q13, Q15, Q17). When the base-emitter junction of Q11 conducts its collector current is used to turn on Q12. The amplification of Q12 is such that, when the oscillator is operating, or a signal is played back in the center frequency of the band of the filter, a voltage of 5.5-7.5 V appears at this collector. The remaining three filter-oscillators perform in the manner described above except that the center frequencies are different. Frequencies of the tones are approximately 375, 750, 1500 and 3000 Hz.

In the playback mode, the playback signal from the B playback amplifier is presented to all four inputs of gate U17. The signal at the control terminal of this gate is high (true) in the playback mode, so that the composite playback signal is presented to each one of the four filters of the decoder. If a signal is present in the center frequency of any or all of the filter bands, then an output of 5.5-7.5 V is presented to the appropriate terminal of 4-bit binary adder U14.

U14 in conjunction with U15 functions as a binary-to-BCD converter. One input to U14 (a binary adder) is the binary output of the tone decoder. The other input is derived via U15. When the input binary code is ⩾ten, a binary six is applied to this input, otherwise it is held at zero. The signals at the output of U14 are a BCD representation of the binary input.

This BCD output is applied to readout-board C to drive the digital display. The units digit of the digital display is wired to always indicate zero. The hundreds digit is enabled only when there is a carry-out from binary adder U14. The BCD output of U14 is applied to the ten's digit via C-U4 (located on readout board) a BCD-to-7 segment decoder. One gate of U15 is used to sense binary zero at the input to U14, in which case oscillator U16 that controls the pulsed readout is shut-off.

In order to save current in the readout display, the lights are pulsed at a rate of approximately 100 pulses per second with a duty cycle of about 10%. This pulsing is accomplished by using two gates of U16 as a free-running multivibrator, and two gates of U16 as a monostable multivibrator, with R123 as a duty cycle control. This output pulse drives amplifiers C-Q1 and C-Q2 on the readout Board C. Because of the high currents involved in driving the LED readouts, the high-current section is placed close to the readout and only those wires that carry very small currents are placed between Board B and Board C. To lengthen battery life, a switch, C-S1, is provided on Board C to disable the readout. Board C also contains the single LED readout, such that when the tape comes to the end, increased tape tension closes switch contacts in A-S3. This closure to ground simultaneously shuts down the power supply and lights CR1.

DATA-IN (1) CONNECTOR				READOUT (2,3)
PIN				
L	H	D	A	
0	0	0	0	BLANK
0	0	0	X	10
0	0	X	0	20
0	0	X	X	30
0	X	0	0	40
0	X	0	X	50
0	X	X	0	60
0	X	X	X	70
X	0	0	0	80
X	0	0	X	90
X	0	X	0	100
X	0	X	X	110
X	X	0	0	120
X	X	0	X	130

X = Closure to ground
0 = Open Circuit

Notes:

(1) dB FULL SCALE switch at AUTO

(2) When pin B of the DATA IN connector is changed from an open circuit to a potential between −5 V and −9 V, the ADD function is enabled. When the ADD function is enabled, 10 dB (20 dB) is added to the readout when a jumper is inserted between pin-jacks A & B (A & C) on the 1935 main board.

(3) When there is no jumper between A & B (A & C) on the main board, activity on the ADD line (pin B) has no effect on the readout.

Figure 3-1. Readout vs. Input at DATA IN connector.

3.7 PLAYBACK CIRCUITS (BOARD 'E') (Figure 5-7).

The playback board is a separate board mounted on the underside of the deck, beneath the head assembly. This board contains the necessary amplification and equalization to raise the head playback signal to a 0.5 V rms level for a normal maximum recorded signal. Two identical channels of playback amplification are provided. The only adjustments contained in the playback chain are gain controls to adjust output level.

Each channel has equalization that is established by standards. This standard playback signal is defined by the NAB and IEC standards as shown in Fig. 4-8. Close-tolerance components (C2, R3 and R4) are used to establish the equalization for the playback, so that no adjustment is required to bring them into proper tolerance. Each playback stage consists of a low-noise discrete circuit, containing all necessary equalization, followed by an integrated-circuit amplifier with flat response.

The gain of the first stage is approximately 26 dB at frequencies above 1 kHz, followed by 40 dB of gain in the IC amplifier. The output of the preamplifier is buffered with 604 ohms to allow operation into any load impedance. This output is shortable, with 0.5 V rms signal at normal maximum recording level. The output of the preamplifiers is directed to gates that allow the signal to pass through to the peak-detector and meter amplifiers, as described in 3.5.

The main record-playback switch, E-S1, located on the playback board is used to route control voltages and switch the supply voltages for the record circuits.

3.8 MOTOR-SPEED CONTROL (BOARD 'D') (Figure 5-11)

The motor-speed control board contains all the circuitry to stabilize the motor speed at approximately 2100 rpm, required to transport the tape at 1 7/8 in./sec. The motor-speed control uses the definition of a fixed-field DC motor; that is, the measurement of the terminal voltage is representative of the rpm of the motor.

Therefore it is only necessary to know the armature resistance, the armature current, and the terminal voltage in order to maintain a constant rpm.

The 1935 motor-speed control contains a bridge circuit that samples the armature current and adjust the motor voltage as required by a changing load. The principle of the motor-speed control follows: Integrated circuit U1 and transistor Q1 form a voltage drive to the motor. The motor current is measured as a voltage across resistor R11. The voltage is amplified and integrated at U2. This voltage, representative of the voltage drop across the resistive portion of the motor, is added to the voltage reference at the motor-drive circuit. The voltage drive to the motor is, therefore, the sum of the reference voltage and a voltage equal to the IR drop across the motor resistance. The current in the motor is strictly a function of motor torque, viz: torque = $KI_a\emptyset$, dependent only on the load. Where K is a motor constant, I_a is armature current, and $\emptyset$ is field flux, constant for permanent-magnet DC motors. If the load on the motor increases, the current in the motor increases. The motor speed control adds a voltage, equal to the IR drop across the motor, to the fixed motor drive voltage, thereby maintaining constant rpm.

In the fast forward, and fast reverse functions, Q1 is saturated, so that the full battery voltage appears across the motor, to increase the motor speed for fast tape motion. Q2 is connected across the motor to short out the back emf of the motor when the remote contact is programmed at the DATA INPUT connector B-S01, on the side of the B Board. This transistor shuts the motor OFF as fast as possible to reduce tape spooling.

Service and Maintenance—Section 4

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4.1 GR FIELD SERVICE.

Our warranty (at the front of this manual) attests the quality of materials and workmanship in our products. When difficulties do occur, our service engineers will assist in any way possible. If the difficulty cannot be eliminated by use of the following service instructions, please write or phone the nearest GR service facility (see back page), giving full information of the trouble and of steps taken to remedy it. Describe the instrument by type, serial, and ID numbers. (Refer to front and rear panels.)

4.2 INSTRUMENT RETURN.

Before returning an instrument to General Radio for service, please ask our nearest office for a "Returned Material" number. Use of this number in correspondence and on a tag tied to the instrument will ensure proper handling and identification. After the initial warranty period, please avoid unnecessary delay by indicating how payment will be made, i.e., send a purchase-order number or (for transportation charges) request "C.O.D."

For return shipment, please use packaging that is adequate to protect the instrument from damage, i.e., equivalent to the original packaging. Advice may be obtained from any GR office.

4.3 SERVICEABILITY TEST.

Follow the procedures outlined below to determine that the 1935 is recording and replaying properly. Before proceeding, check the following things.

1. Be sure to use a new tape and/or that the record defeat tab has not been set on the tape used.
2. Follow preventive maintenance procedures.

CAUTION

Before performing the following tests, clean and demagnetize the heads according to the procedure in para. 4.4.

4.3.1 Data Channel Test With 1933 Sound Level Meter.

The 1933 Sound Level Meter provides a convenient signal generator and analyzer for testing the 1935. The 1933 is set to the CALIBRATE mode, and adjusted through the filter bands, providing 8 useful test frequencies. The recorded tones are then replayed into the 1933. The differences between recorded and playback levels is noted.

Procedure

a. Interconnect the 1933 SLM and 1935 recorder with the 1935-9630 cable.

b. Set the 1933 to CALIBRATE (refer to 1933 instruction book).

c. Set the 1935 to record, i.e., depress the RECORD and PLAY keys. Press PAUSE key also.

d. Adjust CAL A control B-R10 for a CAL reading on the CHANNEL A meter.

e. Set the 1933 OCTAVE BAND control to 63-Hz BAND.

f. Release the 1935 PAUSE key. Record 20-30 sec. at this frequency. Note the 1933 meter reading. Note also the 1935 footage counter indication.

g. Repeat for each BAND up to 8 kHz. (The 31.5-Hz and 16-kHz bands are out of the specification region of the 1935).

h. Rewind the tape to the start of the 1 kHz recorded tone.

i. Connect the 1933-0230 cable from the 1935 CHANNEL A output to the 1933 microphone mast.

j. Set the 1933 source to TAPE and the LEVEL RANGE CONTROL to maximum dB setting. Set the BAND control to 1 kHz.

k. Playback the 1935, i.e., depress PLAY key. The 1933 should indicate full scale. If it does not, increase the gain of the 1935 by adjusting Channel A playback E-R9 control (See Figure 1-3).

l. Set the 1933 BAND control to 63 Hz and note the 1933 meter reading when the 63-Hz tone is played back.

m. Continue to track the played-back tones with the octave BAND on the 1933, observing the readings on the 1933 meter at each frequency.

n. The difference in reading between the 1933 meter readings during record and playback is the R/P error and should not exceed ±2 dB.

In like manner, CHANNEL B may be tested using the 1933 AC OUTPUT and the 1935 CHANNEL B AUX IN with the range code switch OFF. Connection must be made via a miniature phone plug to miniature phone plug cable. This cable may be made up with the plugs supplied with the 1933 and 1935. (Switchcraft type 850 both ends; use 0.125-in. O.D. shielded cable.)

4.3.2 Data Channel Test With Oscillator and Voltmeter.

CHANNELS A and B may be tested in a manner similar to that described above, except that an audio oscillator (GR 1310) and voltmeter (hp 400EL) are substituted for the 1933 sound level meter.

The record level should be set at 0.1 V at frequencies between 50 Hz and 12 kHz, in discrete steps of frequency for easy identification. Use the footage counter to index the span of tape for each discrete frequency recorded. The playback level is 0.1 V rms. Playback readings should be ±2 dB from 50 Hz to 12 kHz.

4.3.3 Range Code Test.

No auxiliary equipment is required to check the RANGE CODE operation.

Procedure

a. Set the 1935 to RECORD, i.e., depress the RECORD and PLAY keys. PRESS the PAUSE key also.

b. Set the RANGE CODE switch to ON. Set the dB FULL SCALE to 40.

c. Set the dB FULL SCALE switch on the front panel to ON.

d. Release the PAUSE key and record about 10 sec. Note the 40 dB full scale reading.

e. Advance the dB FULL SCALE control to 50 dB. Repeat the recording through the 140-dB step, noting that the front panel indicates the number set on the dB FULL SCALE control.

f. Rewind the tape. Proceed to play the tape back, i.e., depress the PLAY key.

g. The front panel dB FULL SCALE digital indicator should display the numbers as sequenced in steps d and e above, except for momentary display of 150 when there is a change of code.

4.4 MAINTENANCE.

4.4.1 General.

Maintenance described in this section consists of regular preventive maintenance to the head tape drive mechanism, and occasional change of heads and rubber drive belts. No oiling of the mechanism is otherwise necessary as these parts are permanently lubricated.

4.4.2 Head and Capstan Drive Cleaning Procedure.

This procedure should be carried out daily with heavy use, or weekly in less frequent use. It should also be carried out after an extended lack of use.

CAUTION

Use only GR Co. 1935-0421 Head Cleaner (Nortonics QM-102), or alcohol, to clean heads. Some liquid and spray cleaners contain solvents that are harmful to the plastic compounds used in the 1935, specifically in the heads and head-mounting assembly. Be certain that the liquid or spray cleaner you purchase is completely safe for plastic, rubber, metal, epoxy parts and painted surfaces — since all of these are present in the 1935. The recommended head cleaner has been specially formulated to clean effectively and is completely safe for these materials. Since it contains no lubricant, it can be safely used to clean the rubber drive parts such as the pinch roller.

Procedure

a. Remove the batteries.

b. Press the STOP key. Hold the cassette compartment lid with one hand and press the cassette holder down (until it latches) with the other hand.

c. Press the PLAY and PAUSE keys. The heads are now accessible for cleaning.

d. Dip a cotton swab (supplied in the tool kit) in the head cleaner (supplied) and clean the capstan shaft, rubber pinch wheel, and head front surfaces. Be sure not to leave cotton particles around the capstan or rubber pinch wheel.

e. Release the cassette lid. Press the STOP and PAUSE key. Replace the batteries. (Note that the heads probably should be demagnetized at this time also.)

4.4.3 Head Demagnetizing Procedure.

This procedure should be carried out as frequently as head cleaning. It should also be performed whenever the deck has been serviced, before making any test of recorder performance, and particularly before a standard test tape is placed in the deck. A magnetized head will cause a reduction in dynamic range of the instrument and may erase recorded tapes.

CAUTION

Do not place the head demagnetizer near recorded tapes as they may become erased.

Procedure

a. Lift the cassette compartment lid as described in para. 4.4.2 (Remove the batteries if they are not already removed.)

b. Plug the demagnetizer (supplied) into a source of 115 Vac.

c. Insert the tips of the demagnetizer in the cassette compartment so that the tips straddle the gap in the center of the metal R/P head. Slowly run the tips up and down several times.

d. Slowly withdraw the tips from the head and similarly demagnetize the capstan shaft, red plastic erase head, and the two cassette posts.

e. Slowly withdraw the head demagnetizer from the recorder.

f. Only after the demagnetizer is several feet from the recorder should the plug be removed from the 115 Vac line.

g. Release the cassette lid. Press the STOP and PAUSE keys. Replace the batteries.

4.5 OPENING THE CASE.

4.5.1 General.

The tape heads and motor-speed-control board 'D', and bias board 'F', are accessible if the top cover is removed. The back of the main board is made accessible, allowing the full scale dB add jumper to be seen, by removal of the bottom cover. Removal of the main board allows access to the preamplifier and motor-drive system. The meter-circuit board 'C' is accessible by removal of the front bezel.

4.5.2 Removing the Front Bezel.

To remove the front bezel, place the instrument on the battery case end. Remove the 2 screws recessed in the holes in the bezel. The bezel will pull of the top of the meter board. The meter board is removed from its mounting by removal of the screws at the end of the board.

4.5.3 Removing the Top Cover.

Remove the front bezel (para. 4.5.2. above). Remove the battery compartment slide and the batteries. Remove the upper two screws inside the battery compartment. Remove the upper screws on the chassis holding the top cover bracket. The top cover will now lift off the instrument.

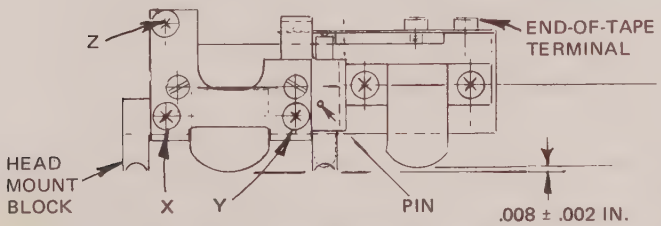

Figure 4-1. Tape-head assembly — top view.

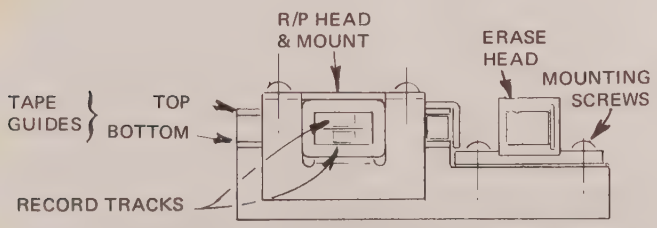

Figure 4-2. Tape-head assembly — face view.

4.5.4 Removing the Bottom Cover.

It is not necessary to remove the top cover or batteries to remove the bottom cover.

a. Remove the bezel (see para. 4.5.2).

b. Stand the instrument on the front bezel end. Remove the screws recessed in the battery compartment.

c. Remove the 2 screws at the bottom of the chassis that hold the bottom cover bracket. The bottom cover will now pull off.

For access to the preamplifier, the component side of the main board, and to the motor-drive belts, remove the 4 small mounting screws in the main board. Swing the board out along the output connector side, using the cable as a hinge with the components of the board facing out.

4.6 CHANGING THE HEADS.

4.6.1 General.

The record and playback heads are subject to wear that will change the electrical performance. Head wear is a function of the amount of recorder use and the regularity of maintenance. In general, normal use of the heads should be in excess of 500 hours; excessive wear would be indicated by pitting or grooving of the heads.

For head replacement for any reason, return the recorder to General Radio for replacement and recalibration.

4.7 CHANGING THE MOTOR DRIVE BELTS.

4.7.1 General.

The rubber motor drive and counter belts are subject to normal wear, which is a function of recorder use and environmental conditions. Worn rubber belts will contribute to poor tape speed, poor fast wind and rewind, and excessive wow and flutter. It is good practice to replace the belts if any of the above indicated conditions occur.

4.7.2 Procedure.

a. Remove the bottom cover and swing out main board (see para. 4.5.4.)

b. Remove and replace the footage-counter belt.

c. Loosen the jam nut, which secures the nylon setscrew in the center of the flywheel bracket. Back this setscrew out, to allow the drive belt to be removed from the flywheel. Remove and replace the drive belt.

d. Reposition the nylon setscrew, such that there is a clearance of .001 to .005 in. between the screw and flywheel hub.

e. While observing the total instrument current drain, (para 4.10.2) tighten the setscrew, until there is a noticeable rise in current drain.

f. Back the setscrew off slightly, until the instrument current drain returns to its previous value, and then tighten the locking jam nut.

g. Replace the chassis-deck mounting screws. Observe that the flywheel drive belt runs free and is not twisted.

Table 4-1

DESCRIPTION OF CALIBRATION ADJUSTMENTS

Name	Control Ref Des.*	Function	Para No.
Battery cal.	C-R15	Sets B meter battery test	4.10.19
Speed	D-R3	Sets motor speed	4.10.12
Stability	D-R13	Sets motor control feedback	4.10.12
Chan. A record	B-R10	Sets record amplifier gain	4.10.4
Chan. B record	B-R6	Sets record amplifier gain	4.10.4
A meter cal.	B-R135	Sets A meter calibration	4.10.4
B meter cal.	B-R136	Sets B meter calibration	4.10.4
AGC level	B-R61	Sets voice mike record level	4.10.20
Tape bias	B-E,D,F	Jumper points to match tape type	—
Oscillator level	B-R24	Sets bias-oscillator level	4.10.7
A bias trap	F-L1	Nulls bias at record amplifier	4.10.8
B bias trap	F-L2	Nulls bias at record amplifier	4.10.8
A bias	F-R1	Sets record bias current	4.10.9
B bias	F-R2	Sets record bias current	4.10.9
A record current	B-R17	Sets record signal current	4.10.6 4.10.16
B record current	B-R31	Sets record signal current	4.10.6 4.10.16
Tone level	B-R116	Sets tone record level	4.10.21
Duty cycle	B-R123	Sets LED drive duty cycle	4.10.22
A playback level	E-R9	Sets playback gain	4.10.5
B playback level	E-R24	Sets playback gain	4.10.5
A record equal	B-L1	Adjusts record high frequencies	4.10.14
B record equal	B-L2	Adjusts record high frequencies	4.10.14
Add select	B-A,B,C	Jumper points for 'add' programming	

*Prefix is board letter designation

h. Place the batteries in the compartment. Set the recorder to PLAY. Check that the motor drive is functioning properly.

i. Reassemble the instrument. No further adjustments should be necessary.

4.8 CHANGING THE CODE RANGE.

4.8.1 General.

As described in para. 3.6, the 1935 can be set to modify the code presented by the 1935 SLM when the 1933 is set to 'MIKE A'. The 1935 can be made to interpret the ADD line as add 0 dB, add 10 dB, or add 20 dB to the normal 4-line code. This feature automatically accomodates the variety of microphones which may be used with the 1933 SLM.

4.8.2 Determining the Proper ADD Program.

If the 1935 is included as part of a 1933 Sound Analysis system, the 1935 ADD function has been factory set for the microphones supplied. If the 1935 has not been set at the factory or if the 1933 microphones have been changed, the 1935 ADD code may be set for automatic reading of FULL SCALE dB. Note that this add program refers only the 1933 MIKE A. The 1933 MIKE B is preset to read 130 dB full scale on the 1935.

4.8.3 Setting the ADD Program.

Remove the 1935 bottom cover as described in para 4.5.4. Refer to Fig. 4-3. The wire jumper used to effect the setting is placed in the spare pin jacks when 130 dB full scale is to be programmed. Place the jumper between pins A and B for 140 dB full scale (the side marked 140), and between pins A and C for 150 dB full scale (the side marked 150).

Test the operation with a 1933 connected to the 1935. Turn the 1933 on. Set the 1935 to RECORD, Chan B to CODE dB FULL SCALE on. Set to full scale. Switch the 1933 source control between MIKE A and MIKE B, and observe the proper dB FULL SCALE reading. Replace the 1935 bottom cover.

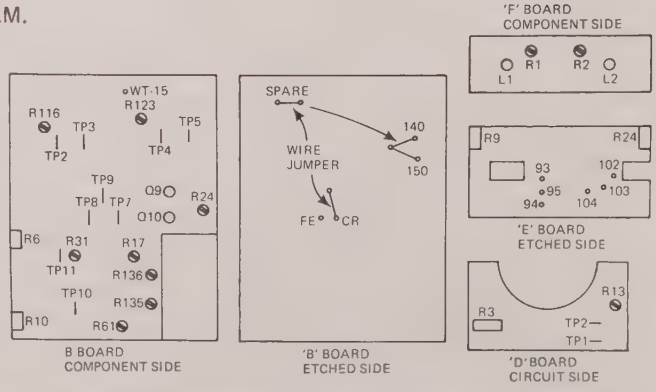

Figure 4-3. Test point/adjustment locations on etched boards.

Table 4-2
TEST EQUIPMENT

Instrument	Requirements	Recommended*
Power Supply	0-10 V, 400 mA	HP6215
AC-DC Voltmeter	Range 0-15 V 2% accuracy	GR-1806
Oscillator	2 Hz - 2 MHz 0-20 V open ckt	GR-1310
Ac Voltmeter	Zin = 10 MΩ Range 1 mV - 300 V	HP 400-EL
Wave Analyzer	25 Hz - 54 kHz linear freq scale Zin = 1 MΩ, 50 Hz Bandwidth, 30 μV - 300 V full scale	GR-1900 A
Counter	General Purpose	GR 1192
Decade Attenuator	0.1-dB, 1-dB, 10 dB steps	GR 1450 TB
Resistive Load	600 Ω ±5%	GR 500-G
Graphic Level Recorder Sweep Oscillator	Zin = 1 MΩ//30 pF Input ±0.1 dB, 1 Hz to 100 kHz Output ±0.1 dB, 1 Hz to 100 kHz, 500 μV to 5 V.	GR 1523 Main Frame GR 1523-P2 Plug-in GR 1523-9621 Pot GR 1523-9650 Chart Paper
Tee, Coaxial (2) Patch Cord (2)	BNC Components Double banana-plug (274)-to double banana plug	UG-274/U GR-274NP
Patch Cord (1) Adaptor (1)	BNC-to-BNC Banana-plug pair to GR874	GR-776-C GR 874-Q10
Adaptor (1)	BNC jack to GR874	GR-874-QBJA
Adaptor Cable (3)	Double banana-plug (274) to miniature phone plug	GR 1560-P77
Patch cord (1)	Single banana-plug to banana plug	GR-274-LLB
Adaptor Cable (2)	BNC (male) to miniature phone plug	GR-1560-P79
Adaptor Cable (2)	274 (double) to clips	Make Up
Adaptor Cable	274 (double) to miniature phone plug (must fit larger jack of voice interrupt)	Make up use Switchcraft 750 plug
Short-Circuit	Miniature phone plug short-circuit (must fit small jack of voice interrupt)	Make Up
Probe	X1	Tektronix P6011
Sound-Level Meter, Precision	Range 10-130 dB Flat and A weighting response	GR-1933
Adaptor Cable	1935 to 1933 data	GR 1935-0231
Adaptor Cable	Miniature phone plug to 1933 microphone mast	GR 1933-9602
C-60 Tape Cassette	Crolyn (30 min)	GR 1935-0430
Test Tape Cassette	6300 Hz Azimuth 333 Hz Level 3150 wow/flutter	BASF Service Cassette (Fe) #87122 (Table 4-3)
Wow/Flutter Meter	0.5 Hz - 200 Hz 0.01%	Manke Inst. Model M-1
Adaptor Cable	1933 Microphone mast to clips	Make Up

* Or equivalent

Table 4-3
STANDARD CASSETTE TAPE

Type No.	Supplier
QM 440-AT200	Nortronics Co., Inc. 6140 Wayzata Blvd. Minneapolis, Minn.
87122	BASF Systems Crosby Drive Bedford, MA 01730
TC-FR	North American Phillips Corp. Home Entertainment Products Div. 100 East 42 St. New York, New York 10017

4.9 CALIBRATION ADJUSTMENTS.

Table 4-1 is a complete list of calibration controls in the 1935, with the identifying part number, and function description. The para. number locates the test given in the calibration procedure.

4.10 TEST AND CALIBRATION.

These procedures should be followed after the instrument has been repaired or when the test of para. 4.3 shows that the instrument may not be working according to specification. Refer to para. 4.5 for disassembly.

4.10.1 Preliminary Mechanical Checks.

1. Position the 1935 so you are facing the tape heads (control levers at top). Activate the third lever from the left (play). The tape heads and pinch roller should move toward the tape cassette holder to a distance as indicated in Fig. 4-4 for proper penetration of tape heads.

2. Check for clearance between the pinch-roller finger and the pinch-roller lifting tab (see Fig. 4-4). The minimum clearance should be a distance equal to the thickness of the pinch-roller lifting tab. Bend the lifting tab with needle-nose pliers.

Activate the left-most lever (PAUSE) and note that the pinch roller lifts off of the capstan. Check the pause lever for excessive dead-zone movement. The dead zone should be less than about 1/8-in travel at the tip of the pause lever.

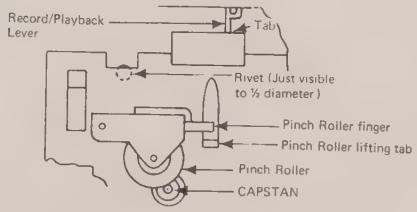

Figure 4-4. Pinch-roller assembly detail.

Dead zone is the free movement of the lever before it engages the pause linkages. To remove the dead zone, bend the tab (from the rear of the deck) that has a spring mounted to it, down until it captivates the Pause lever.

3. Check the capstan flywheel to be sure that there is no end play in the capstan shaft. Any end play will cause the tape to move laterally across the record/playback tape head during record and playback modes. This undesirable tape motion will produce excessive amplitude modulation of the recorded signal. A misaligned pinch roller can also produce this effect. The tape deck must be removed from the frame in order to adjust the restraining bracket, using the 3 screws located on the side of the deck.

4. Check the functioning of the 3 digit counter. Rotate the digital barrels, using a finger, to a count of from 4's to 6's on the barrels. Push the reset button. As this is being done, the 3 small gears will move away from the digital barrels to allow the barrels to rotate freely. Note that there is a cam located on the gear side of each digital barrel. Three fingers, located behind the digital barrels, engage the cams to rotate the digits to zero. If the reset is abused, it is possible to break off one or more of these fingers. The corresponding digit will not return to zero. The other potential problem area with the counter concerns the operation of the three small gears. Two small phosphor bronze springs should engage the 3 gears when the reset is pushed. These springs align the gear teeth so that the small gears will mesh with the large gears. The springs may require straightening if proper mesh is not obtained.

5. Check that the wires and cable leading to the tape heads are strain-relieved by a lug fastened to the head-mounting block. Check that the small phosphor bronze clip has been installed under one of the motor mounting screws. This clip grounds the motor housing to chassis ground to prevent electrical-charge build-up. If not grounded, an occasional pop will be heard in the output of the recorder as the static charge jumps to ground.

6. A small micro switch is located beneath the Channel B meter and activated by the forward/rewind levers. Slowly push the rewind lever in, while listening for the click of the micro switch. The micro switch should have a small amount of overtravel beyond the click before the rewind lever is fully engaged. The wire finger of the micro switch must not ride up onto the rewind lever. Nor should it fall into the crack between levers when the rewind lever is disengaged. The forward lever should activate the micro switch in a similar manner.

7. Check for clearance between the 4 right-hand levers and the meter terminals. If touching, bend the terminal(s) up tight against the meter housing.

CAUTION

When not working with the recorder, always set the control levers to their disengaged positions to prevent the formation of flat spots on rubber wheels.

4.10.2 External Power-Supply Connection.

Connection of an external supply is recommended to prevent excessive current drain on the batteries during test and calibration. Internal batteries should be removed before applying external power.

a. Mount the main board as detailed in para 4.5.4 and stand the instrument on the battery compartment.

b. With the HP 6215 Power Supply output set to zero, connect the negative output (–) to the recorder battery terminal having the wh-bk leads. Connect the positive terminal of the power supply to the recorder battery terminal having the wh -or- bl lead. Use the double banana plug (274) to clip leads.

4.10.3 Power Supply Check.

a. Set the 1935 controls as follows:

BAT CHECK/CHAN B (center of display panel) . . . . . Chan B (slide right)
RANGE CODE (below LED display) . . . . . OFF (slide right)
PAUSE (right-most lever) . . . . . .Engaged
PLAY (third lever from right) . . . . .Engaged
RANGE CODE ON/OFF . . . . . OFF
dB FULL SCALE . . . . . AUTO

b. Connect the 1806-A Voltmeter to the output of the HP 6215 Supply, using a 274-patch cord.

c. Set the power supply meter-selector switch to mA and then slowly increase the supply voltage to 6 V as monitored on the 1806. The supply current should in no way exceed 400 mA as monitored on the supply meter. Nominal supply current should be about 120 mA.

d. Using the 1806 check the –9 V supply at B-WT52 (green wires) to be –9.0 ±0.5 V. Use the WH – BK wires on the battery holder for the ground side of the 1806.

e. Check the +9 V supply at B-WT51 (blue wires) for the same tolerance as above.

f. While monitoring the +9 V supply, vary the input voltage from 5.5 to 7.5 and then back to 6 V. The supply should not change more than ±0.4 V.

g. Release the PAUSE and observe the current drain on the 6215 Power Supply. Typically, this should increase by approximately 20 mA.

h. Depress the stop and enter the record mode (RECORD and PLAY depressed). Nominal supply current should be about 180 mA. Depress the PAUSE, typical current drain should decrease by approximately 20 mA.

i. Set the slide switch below the LED display to ON, set the range code switch ON and the dB FULL SCALE switch to 140. Nominal supply current should be approximately 200 mA.

j. Release the PAUSE. Typical current drain should increase by approximately 20 mA.

k. Depress the STOP to halt the recorder, set the slide switch below the LED display off, set the RANGE CODE switch to OFF and dB FULL SCALE switch to AUTO.

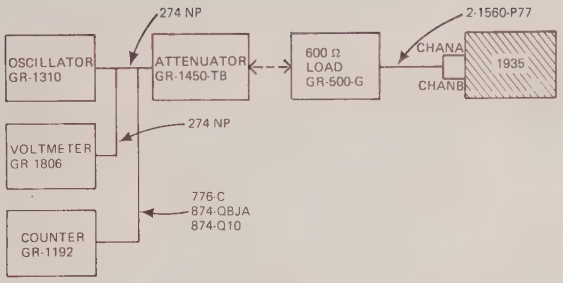

Figure 4-5. Test setup for Record Equalization Check

4.10.4 Record Amp Calibration and Equalization Check.

a. Connect CHAN A and CHAN B AUX IN jacks of the 1935, using the test setup shown in Figure 4-5.

b. Set the controls as follows:

1310
Frequency Range . . . . . 200 Hz – 2 kHz
Frequency Dial . . . . . .10 (1 kHz)
Level . . . . . Adjust for 1 V on 1806
1450
Attenuation . . . . . 6.0 dB

c. Place the 1935 in the record mode (RECORD and PLAY depressed).

NOTE

In order to activate the record lever with no cassette installed, first push down the cassette sensing finger located on the right bottom side of the cassette holder.

d. Connect the 400EL Voltmeter (1 V Range) to B-TP10 using the P6011 probe. (Use the shield around the power supply for voltmeter ground on the main board.) Adjust CHAN A CAL pot for a reading of 0.5 V.

e. Adjust the CHANNEL A meter CAL POT (B-R135) to center the pointer of the CHAN A meter to center scale.

NOTE

B-R135 is located adjacent to the lower hybrid circuit on the main board (Figure 5-6).

f. Check the output frequency response of the CHAN A record amplifier in accordance with Table 4-4 by first setting the 1310 Oscillator and 1450 Attenuator and noting the readings on the 400EL Voltmeter. (0 dB on the voltmeter is the established reference point.) A typical record head equalization response is shown in Figure 4-6.

g. Move the 400EL Voltmeter to B-TP-11 on the 1935. Set the 1450 to 6.0 dB, 1310 to 1 kHz, and adjust CHAN B CAL pot for a reading of 0.5 V.

h. Adjust the CHAN B meter CAL POT (B-R136) to center the pointer of the CHAN B meter to center scale.

NOTE

B-R136 is located adjacent to the upper hybrid.

i. Check the output frequency response of CHAN B record amplifier in accordance with Table 4-4.

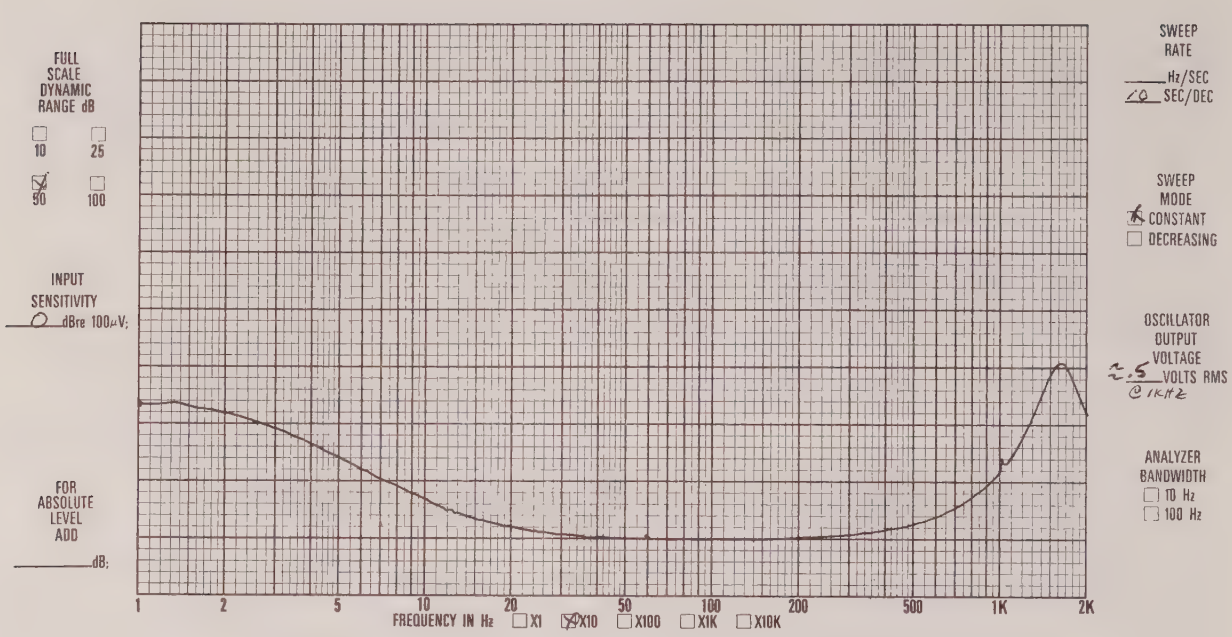

Figure 4-6. GR1523 recording of record-head current vs frequency.

Table 4-4

CHAN A & B RECORD AMPLIFIER RESPONSE

Frequency of 1310	1450 Attenuation	400EL Reading
1 kHz	2.2 dB	0 ± 1.0 dB
100 Hz	5.3 dB	0 ± 1.0 dB
20 Hz	13.2 dB	0 ± 1.0 dB
10 kHz	7.6 dB	0 ± 1.5 dB

j. Activate the STOP lever to halt the 1935 and disconnect from the setup.

4.10.5 Preliminary Playback Adjustment and Equalization.

a. Connect to E-WT95 of the 1935 using the setup of Figure 4-7. Connect the positive output terminal of the 1450 through the 600-Ω load to E-WT95 (GY cable, white wire). Connect the negative output terminal of the 1450 to E-WT94 (GY cable, shield).

NOTE

This effectively terminates the 1450 with 610 ohms, the 600 Ω load plus the 10 ohms between WT95 and WT94.

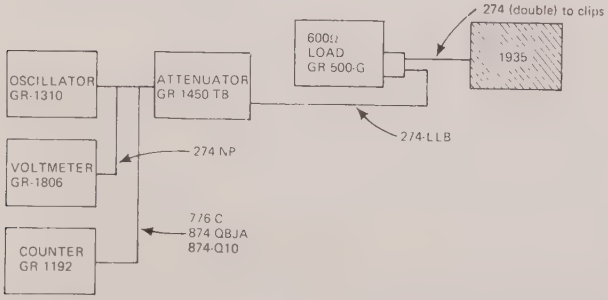

Figure 4-7. Test setup for Playback Level Adjustment

Table 4-5

CHAN A & B PLAYBACK AMPLIFIER RESPONSE

Frequency of 1310	1450 Attenuation	400EL Reading
1 kHz	30.1 dB	0 ± 1.0 dB
100 Hz	44.5 dB	0 ± 1.0 dB
20 Hz	47.1 dB	0 ± 1.0 dB
10 kHz	26.1 dB	0 ± 1.5 dB

b. Connect the 400EL Voltmeter (1-V range) to the 1935 OUTPUT A using a 1560-P79 patch cord.

c. Set the controls as follows:

1310

Frequency Range . . . . . 200 Hz – 2 kHz
Frequency Dial . . . . . 10 (1 kHz)
Level . . . . . Adjust for 1 V on 1806

1450

Attenuation . . . . . 33.9 dB

d. Place the 1935 in the playback mode.

e. Adjust E-R9 (accessible through left side panel) for a reading of 0.5 V on the 400EL.

f. Check the output frequency response of the CHAN A playback amplifier in accordance with Table 4-5 by first setting the 1310 Oscillator and 1450 Attenuator and noting the readings on the 400EL Voltmeter. A typical playback equalization response is shown in Figure 4-8. (0 dB on the voltmeter is the established reference point.)

g. Move the Voltmeter to OUTPUT B on the 1935.

h. Move the input connections of E-WT95 and E-WT94 to E-WT104 and E-WT103, respectively (WT104, WH-VT cable, white wire; WT103, WH-VT cable, shield).

i. Set the 1450 to 33.9 dB, 1310 to 1 kHz, and adjust E-R24 (accessible through right-side panel) for a reading of 0.5 V on the 400EL.

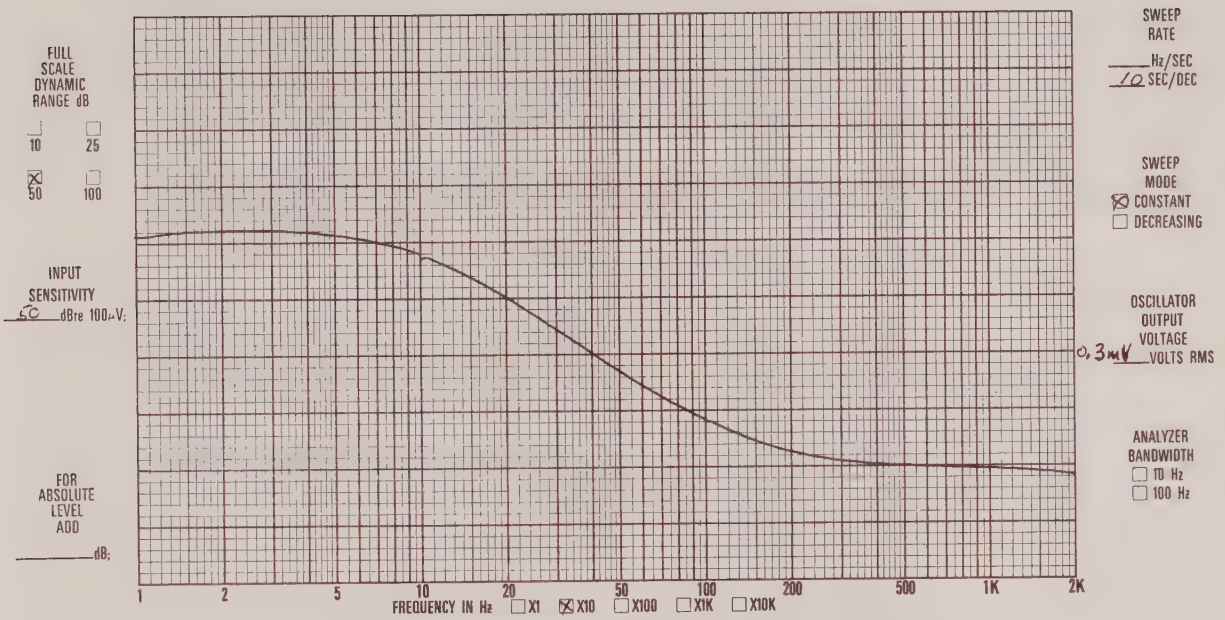

Figure 4-8. Playback equalization characteristic as plotted on GR1523.

j. Check the output frequency response of CHAN B playback amplifier in accordance with Table 4-5.

k. Activate the STOP lever to halt the 1935 and disconnect from the setup.

4.10.6 Preliminary Record Head Current Adjustment.

a. Unplug the bias oscillator transistors B-Q9 and B-Q10.

b. Connect to both CHAN A and CHAN B AUX IN jacks of the 1935 using the test setup shown in Figure 4-9.

c. Connect the 1933 SLM microphone mast to E-WT95 on the 1935, using the microphone mast to clip lead cable (positive to GY cable, white lead and negative to GY cable shield).

d. Set the controls as follows:

1933

Band Switch	WEIGHTING
Maximum mike dB	130
dB Level Switch	60-70-80
IMP/SLOW buttons	both released
FLAT	depressed
SOURCE	TAPE

1310

Frequency Range	200 Hz – 2 kHz
Frequency Dial	10 (1 kHz)
Level	Adjust for 0.5 V on 1806

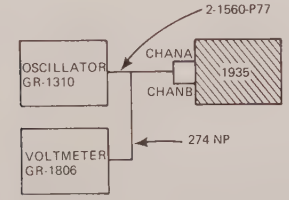

Figure 4-9. Test set-up for Chan A & B Record Input

e. Set the 1935 to record mode (RECORD and PLAY depressed).

f. Adjust B-R17 for a reading of 71.6 dB (0.6 mV) on the 1933.

g. Move the 1933 connection from E-WT95 to E-WT104 (positive to WH-VT cable, white lead and negative to WH-VT cable shield) and adjust B-R31 for a reading of 71.6 dB.

h. Stop the 1935, reinstall the transistors B-Q9, B-Q10 and disconnect the 1935 from the setup.

4.10.7 Bias Oscillator Level Adjustment.

a. Connect the 400EL Voltmeter (1-V Range) to B-WT35. (Use the shield around the power supply for voltmeter ground on the main board.)

b. Place the 1935 in the record mode.

c. Adjust B-R24 (OSC. LEVEL) for a reading of 0.4 V on the 400EL.

d. Connect the 1192 counter to the same TP (B-WT35) as the voltmeter and measure the oscillator frequency. The 1192 should read between 79.5 and 87.0 kHz.

NOTE

The inductance of the erase head (2 mH/Channel) is the dominant inductive component of the bias oscillator in determining the frequency of oscillation. The net inductance is determined by the erase head inductances in parallel with transformer T1. If one erase head channel should become open-circuited for any reason, the oscillator frequency will be about 3/4 the normal reading.

4.10.8 Bias-Trap Adjustment.

a. Connect the 400EL Voltmeter (1-V range) to B-TP7.

b. Set 1935 to record mode.

c. Adjust F-L1 for a null on the 400EL. The voltage reading should be <0.5 V rms.

d. Move the 400-EL to B-TP8 and repeat the null procedure by adjusting F-L2. This should also be <0.5 V rms.

NOTE

F-L1 is located on the small board adjacent to the tape beads.

4.10.9 Record Head-Bias Current Adjustment.

a. Connect the 400EL Voltmeter (.01 V Range) to E-WT95 (positive to GY cable white lead, and negative to GY cable/shield).

b. Set 1935 to record mode.

c. Adjust F-R1 (bias level) for a reading of 3.5 mV on the 400EL.

d. Move the 400EL Voltmeter to E-WT104 and adjust F-R2 for a reading of 3.5 mV (positive to VT cable/white lead, and negative to VT cable/shield).

e. Depress STOP on the 1935 and activate the PLAY lever.

f. The 400EL Voltmeter reading should drop to zero at WT-104. This test indicates that the RECORD PLAYBACK switch located on the E board is functioning properly.

g. Activate the STOP lever to halt the 1935.

4.10.10 RECORD/PLAYBACK Head Azimuth Alignment.

a. This check uses the BASF Standard Test Tape as a signal source. It is very important that the Standard Test Tape Cassettes receive careful treatment when being used, to prevent inadvertent partial or total erasure of the test signals. (Refer to Table 4-3 for sources of standard test tapes.)

b. Before inserting the standard test-tape cassette, demagnetize the heads. Refer to para. 4.4.3. Also, demagnetize any tools used for the adjustment.

CAUTION

If omitted, the signal levels recorded on the tapes may be slightly reduced each time the tapes are played.

c. Unplug bias-oscillator transistors B-Q9 and B-Q10 to prevent accidental erasures of the standard tape.

d. Connect OUTPUT A of the 1935 to the 400 EL Voltmeter (1-V Range) using a 1560-P79 patch cord.

e. Install the standard Test Tape, locate the 6300 Hz section and start the recorder in the playback mode (depress PLAY).

f. Adjust screws X and Y to obtain a maximum reading on the 400EL. This adjustment should be done using the following sequence to minimize the misalignment of tracks between both heads. Refer to Fig. 4-1.

g. Note voltmeter reading then turn screw X for maximum reading.

h. Turn screw X back half the distance turned and turn screw Y for maximum reading. Any misalignment of tracks between heads will be found in 4.10.11 when testing eraseability.

i. Stop the 1935 and remove the test tape when the above adjustment has been completed.

j. Reinstall transistors B-Q9 and B-Q10.

4.10.11 Erase Test.

a. Connect to both CHAN A and CHAN B AUX IN jack of the 1935 using the test setup shown in Figure 4-9.

b. Connect the 1900-A Wave Analyzer to the 1935 OUTPUT A using a 1560-P77 patch cord.

c. Set the controls as follows:

1310

Frequency Dial	10 (1 kHz)
Frequency Range	200 Hz – 2 kHz
Output Level	Adjust for 1 V on 1806

1900-A

Bandwidth CPS	.50
Δ F – CPS	0
Mode	Normal
Reading	Relative
Full-Scale Knob	1 V
Full-Scale Dial	1 V
Meter Speed	FAST

d. Insert a regular cassette (P/N 1935-0430) and reset the tape-length counter to zero.

e. Set the 1935 to the record mode and record a 10-count section of tape before stopping the recorder.

f. Rewind the tape (depress REWIND) to a count of 5, disconnect the 1310 from CHAN A and CHAN B AUX IN and rerecord (erase) up to a count of 10 again.

g. Rewind the tape to a count of 0 and place the 1935 in the play mode. Tune the 1900 Wave Analyzer to the frequency of the output signal (1 kHz) and adjust the Δ F control for a peak response on the meter. Adjust the RELATIVE GAIN control for a full-scale reference reading on the 1900. These adjustments must be completed before the tape reaches the point (count of 5) at which the signal was erased. Rewind tape and replay as necessary.

h. Let the tape continue into the erased portion (count 5 to 10) and rotate the FULL SCALE KNOB ccw for an on-scale reading of the 1900. The erased signal must be greater than 50 dB below the recorded signal.

i. Move the 1900 from OUTPUT A to OUTPUT B on the 1935 and repeat steps g through h to test the erasibility of CHANNEL B.

j. If either channel fails to pass this test the R/P head is probably misaligned. Refer to para. 4.6.3 for head alignment.

k. Stop the 1935, remove the tape cassette and disconnect the setup.

4.10.12 Motor Speed Stability Adjustment.

a. Unplug the bias-oscillator transistors B-Q9 and B-Q10 to prevent accidental erasure of the standard tape. Remove

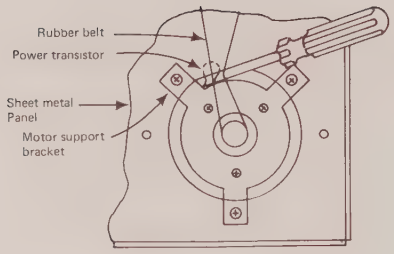

Figure 4-10. Method of increasing loading on motor.

the protective shield over the belts and motor.

b. Connect the 1192 Counter to OUTPUT A on the 1935 using a 1560-P79 patch cord.

c. Install the BASF Standard Test Tape in the 1935, locate the 3150 Hz section and start the recorder in the playback mode.

d. Adjust D-R3 for a reading of 3.15 kHz as read on the 1192 counter.

e. The stability control must now be set so that when the motor load is increased, the speed will remain constant. Place a small screwdriver having a round metal shaft through the sheet metal panel of the tape deck above the motor as shown in Fig. 4-10.

f. Note the counter reading, and then move the screwdriver across the top of the motor-support bracket until it begins rubbing against the rubber belt. Continue this movement until the Recorder Supply Current has increased by 20 mA (as observed on the supply meter) above its free-running current. A slight downward force applied to the screwdriver will wedge it in place so that a steady load can be held.

g. If the stability control is correctly positioned, the counter reading should not change more than ±30 Hz. If the reading changes more than 30 Hz adjust the stability. If frequency decreases with load — turn D-R13 cw. If frequency increases with load — turn D-R13 ccw.

h. The stability control when changed will also affect the motor speed, therefore, each time this control is moved, release the load, note the new counter reading, apply the load, and check for no change (±30 Hz) in counter reading.

i. After arriving at the proper stability setting, readjust R3 (SPEED) for a reading of 3., 5 kHz.

j. Do not disturb the setup if the flutter test (para 4.10.13 is to be performed. Otherwise, stop the 1935, remove the test tape and reinstall B-Q9 and B-Q10.

4.10.13 Wow and Flutter Test.

a. Unplug bias-oscillator transistors B-Q9 and B-Q10 to prevent accidental erasure of the standard tape.

b. Install the BASF Standard Test Tape in the 1935. locate the 3150 Hz section, and start the recorder in the playback mode.

c. Connect the Wow and Flutter Meter to OUTPUT A on the 1935, using a 1560-P77 patch cord.

d. Check that the wow and flutter is less than 0.3% rms.

e. Stop the 1935 and remove the test tape. Reinstall B-Q9 and B-Q10.

4.10.14 Frequency-Response Plot.

a. Using the setup shown in Figure 4-11, connect the 1523-P2 OUTPUT to the CHAN A and CHAN B AUX IN jacks of the 1935.

b. Set the controls as follows:

400EL

Range . . . . . 0.1 V

1523 — Mainframe

1523-9650 Chart paper installed

1523-9621 25-dB potentiometer installed

1523-P2

Output Voltage Range . . . . . .500 mV

POWER . . . . . Depressed

Output Voltage Vernier. Set for 0.1 V on 400 EL

Frequency Sweep Hz

START Sweep. . . . . 10 Hz

STOP Sweep . . . . . 20 kHz

Sweep Time — Per Decade . . . . . 5 x 10 sec.

Seconds Per Decade . . . . . Constant

Decade Length 3

Reset Mode. . . . . Repeat Chart

Sensitivity (dB) 50

Pen Auto . . . . . Depressed

c. Insert a regular cassette (P/N 1935-0430) and reset the tape length counter to zero.

d. First depress the PAUSE lever and then activate for the record mode.

e. Simultaneously, release the 1935 PAUSE and push the 1523-P2 RUN button.

f. As soon as the 1523 enters its reset mode, stop the 1935 and then rewind the tape several counts beyond zero.

g. Disconnect the 1935 from the 1523-P2 OUTPUT.

h. Connect OUTPUT A of the 1935 to the SIGNAL INPUT of the 1523-P2 using a 1560-P79 patch cord.

i. Start the 1935 in the playback mode and get ready to push the 1523 RUN button as soon as the pen lifts off its lower stop, indicating that the recorder has arrived at the 20-Hz start point.

j. After plotting CHAN A's response, move the 1523-P2 SIGNAL INPUT to OUTPUT B on the 1935 and repeat the same procedure to plot CHAN B's response.

k. Both frequency response plots should fall within a 4-dB range from 100 Hz to 3 kHz, and within a 6-dB range from 20 Hz to 100 Hz, and from 3 kHz to 12 kHz. If either

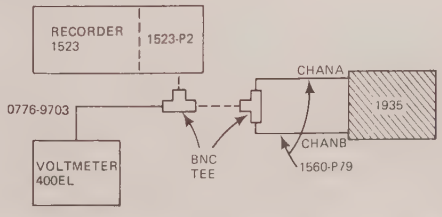

Figure 4-11. Test setup for Frequency Response Check.

channel fails to meet this requirement at high frequency, adjustments might be necessary to improve this response. The high-frequency response can be decreased by increasing the bias current or increased by decreasing bias current. Refer to para 4.10.9 for bias-current adjustment. The high-frequency response can also be adjusted by increasing or decreasing (by 5 mH increments) the value of B-L1 and B-L2 for channel A and B, respectively. Decreasing the value of this inductance will lower the high-frequency response or increasing its value will raise the response.

l. Stop the 1935 and disconnect it from the setup.

4.10.15 Final Playback-Level Adjustment.

a. Connect the 400-EL Voltmeter (0.3-V range) to OUTPUT A on the 1935, using a 1560-P79 Patch Cord.

b. Unplug bias-oscillator transistors, B-Q9 and B-Q10.

c. Install the BASF Standard Test Tape in the 1935, locate the 333 Hz section, and start the recorder in the playback mode.

d. Adjust E-R9 for a reading of 0.19 V on the 400-EL.

e. Move the 400-EL Voltmeter to OUTPUT B on the 1935.

f. Likewise, adjust E-R24 for 0.19 V on the 400-EL, during playback of the 333-Hz portion.

g. Stop the 1935 and remove the test tape. Reinstall B-Q9 and B-Q10.

4.10.16 Final Record Head Signal-Current Adjustment.

a. Connect both CHAN A and CHAN B AUX IN jacks on the 1935 using the test setup shown in Figure 4-9.

b. Connect the 400EL Voltmeter (1-V Range) to OUTPUT A on the 1935, using a 1560-P79 patch cord.

c. Set the 1310 controls as follows:

Frequency Range	200 Hz – 2 kHz
Frequency Dial	10 (1 kHz)
Level	Adjust for 0.5 V on 1806

d. Insert a regular cassette (P/N 1935-0430) and reset the tape length counter.

e. Start the 1935 in the record mode and record a short section of tape, about 10 counts long.

f. Rewind the tape to the beginning of the recorded section and activate the 1935 for the playback mode. Note the reading on the 400EL with respect to 0.5 V (greater or less).

g. Depress the 1935 PAUSE and then adjust B-R17 (CHAN A head cal), in a cw direction if the playback level was below 0.5 V, or in a ccw direction if the level was greater than 0.5 V.

h. Connect the 400EL to OUTPUT B on the 1935, release the PAUSE and note the reading on the voltmeter with respect to 0.5 V.

i. Depress the 1935 PAUSE and then adjust B-R31 (CHAN B head cal) cw or ccw in a similar manner as used in step g.

j. Advance the tape beyond the previously recorded section and then reset the counter.

k. Record another 10 counts of the 1 kHz signal at 0.5 V.

l. Check the playback levels of Channel A and B again to determine if they are now 0.5 ±.02 V.

m. If the level of 0.5 V is not met, go back to step g and repeat the adjustment procedure on either or both channels. Several passes may be necessary.

n. During playback of Channel A and B, note that the pointer of the respective meters are at center scale.

o. Stop the 1935.

4.10.17 Distortion Check.

a. Connect both CHAN A and CHAN B AUX IN jacks of the 1935, using the test setup shown in Figure 4-9.

b. Connect the 1900-A Wave Analyzer to the 1935 OUTPUT A using a 1560-P77 patch cord.

c. Set the controls as follows:

1310

Frequency Dial	10 (1 kHz)
Frequency Range	200 Hz – 2 kHz
Output Level	Adjust for 1.1 V on 1806

1900-A

Bandwidth CPS	50
ΔF - CPS	0
Mode	Normal
Reading	Relative
Full-Scale Knob	1 V
Full Scale Dial	1 V
Meter Speed	FAST

d. Insert a regular cassette (P/N 1935-0430) and reset the tape length counter to zero.

e. Set the 1935 to record mode and record a section of tape 10 counts before stopping the recorder.

f. Rewind the tape to a count of 0 and place the 1935 in the playback mode. Tune the 1900 Wave Analyzer to the frequency of the output signal (1 kHz) and adjust ΔF control for a peak response on the meter. Adjust the RELATIVE control for a full-scale reference reading on the 1900.

g. Tune the 1900 to 2 and 3 kHz, respectively, (first and second harmonic). Rotate the FULL SCALE knob ccw for an on-scale reading. The over-all distortion of first and second harmonic must be less than 3%. Refer to Table 4-6 These adjustments must be completed before the recorder gets to the end of the recorded signal. Rewind the tape and replay as necessary.

h. Move the 1900 input to OUTPUT B on the 1935 and repeat distortion checks for Channel B starting with step f.

i. Stop the 1935.

4.10.18 Noise-Level Check.

a. Connect both CHAN A and CHAN B AUX IN jacks of the 1935, using the test setup shown in Figure 4-9.

b. Connect the 1933 SLM microphone mast to the 1935 OUTPUT A, using a P/N 1933-9602 cable.

Table 4-6

OUTPUT DISTORTION <3%

If First Harmonic Is Between (mV)	Second Harmonic Must Be < (mV)
6-7	29.2
7-8	28.9
8-9	28.6
9-10	28.2
10-11	27.9
11-12	27.5
12-13	27.0
13-14	26.5
14-15	25.9
15-16	25.4
16-17	24.7
17-18	24.0
18-19	23.2
19-20	22.4
20-21	21.5

c. Set the controls as follows:

1310

Frequency Dial . . . . . .10 (1 kHz)
Frequency Range . . . . . 200 Hz – 2 kHz
Output Level . . . . . .Adjust for 0.5 on 1806

1933

Band Switch . . . . . .WEIGHTING
Maximum mike dB 130
dB Level Switch . . . . . 110 – 120 – 130
IMP/SLOW Buttons . . . . . .Both released
A . . . . . .Depressed

d. Insert a regular cassette (P/N 1935-0430) and reset the tape length counter to zero.

e. Set the 1935 to the record mode and record a section of tape 10 counts before stopping the recorder.

f. Rewind the tape and place the 1935 in the playback mode. Note the level of the recorded signal on the 1933 and depress PAUSE. Rotate the dB level control ccw for an on-scale reading of the 1933. The A-weighted output should be down 43 dB or more from the playback level.

g. Connect the 1933 to OUTPUT B and determine the difference between the playback level and the noise threshold as in step f. The A-weighted output level of Channel B should also indicate 43 dB (or more) down.

h. Stop the 1935 and disconnect it from the setup.

4.10.19 Battery Cal Adjustment.

a. Install the front bezel over the display board if not already in place. (Position but do not secure.)

b. Adjust the hp 6215 Supply to 5.5 V (Monitor this voltage on the 1806 Voltmeter.)

c. Activate the 1935 for the play-pause mode. Set the CHANNEL B switch to BAT CHECK and note the meter reading with respect to the line marked BAT on the front bezel.

d. The meter should read at the lower end of the BAT line; if not, remove the bezel and adjust C-R 15 as judged necessary for proper indication of the meter. Install the bezel and check the meter position again. Repeat this procedure until the meter pointer is at the lower end of the BAT line.

e. Set the CHANNEL B switch back to CHAN B and remove the bezel.

f. Readjust the hp 6215 Supply to 6 V and stop the 1935.

4.10.20 Microphone Circuit AGC Adjustment.

a. Connect the CHANNEL B mike input using the test setup shown in Figure 4-12 (1935 input to voice interrupt, larger phone jack). Insert the miniature phone plug short circuit in the smaller phone jack.

b. Set the controls as follows:

1450-TB

Attenuation . . . . . 40 dB

1310

Frequency Dial . . . . . .10 (1 kHz)
Frequency Range . . . . . 200 Hz – 2 kHz
Output Level . . . . Adjust for 0.5 V on 1806

1935

dB FULL SCALE knob . . . . . AUTO
Range Code (Channel B) switch . . . . . ON

c. Connect the 400EL Voltmeter (1 V Range) to B-TP11.

d. Set the 1935 to the record-pause mode and adjust B-R61 (AGC level) for a reading of ≈0.25 V on the 400EL. The Channel B meter should be deflected 1/4 full-scale.

e. Set the 1450 to 56 dB. The 400EL should settle to a reading >0.20 V, indicating the AGC action has taken place.

f. Set the RANGE CODE (Channel B) switch OFF. The output signal on the voltmeter should drop.

g. Stop the 1935 and disconnect it from the setup.

4.10.21 Range-Code Check.

a. Connect the 1933 DATA OUT socket to the 1935 DATA IN and OUT socket using the 1935-0231 Cable.

b. Connect the 400EL Voltmeter (3-V Range) and the 1192 Counter to TP5 on the 1935.

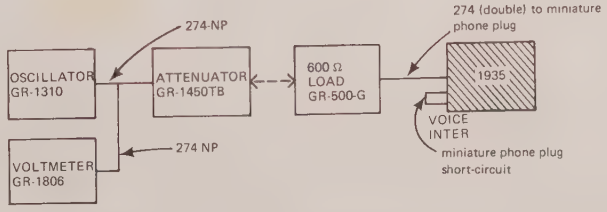

Figure 4-12. Test Setup for Microphone Input

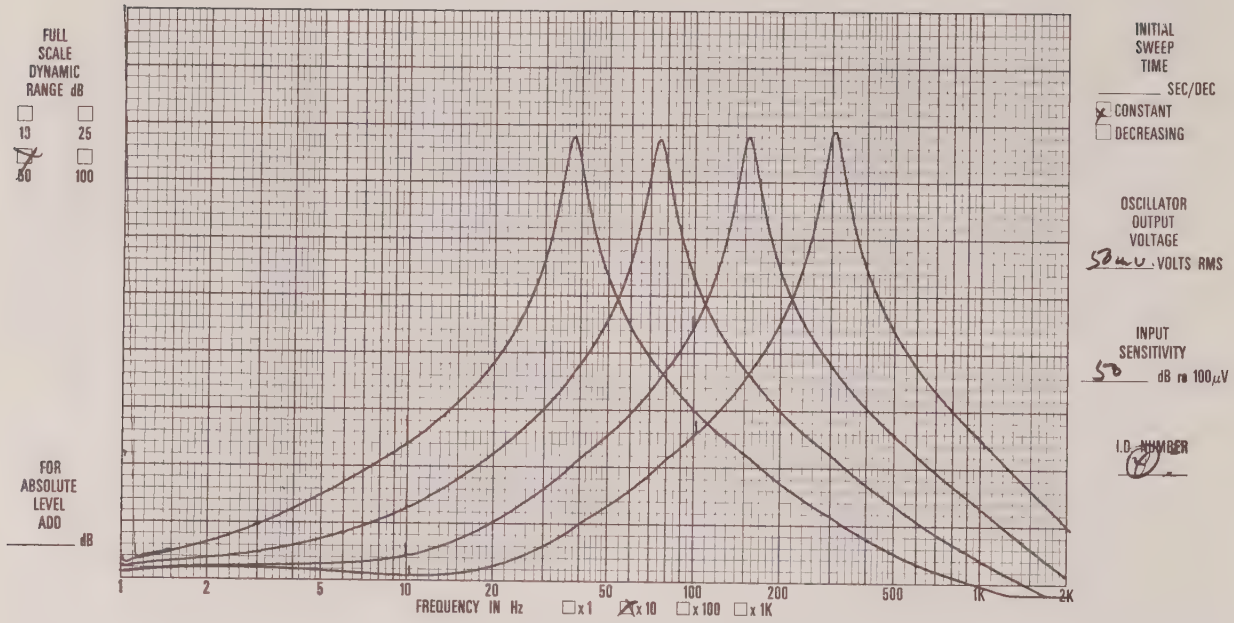

Figure 4-13. Typical tone filter response plotted on GR1523.

c. Set the controls as follows:

1933

Band Switch . . . . . WEIGHTING
Maximum Mike dB 130
dB Level Switch . . . . . .110 – 120 – 130
IMP/SLOW Button . . . . . Both released
FLAT . . . . . depressed

1935

dB FULL SCALE. . . . . AUTO
Range Code (Channel B) Switch . . . . . ON
LED Display Switch . . . . . ON
PAUSE Lever . . . . . Engaged
RECORD-PLAY Levers. . . . . Engaged

d. Rotate the 1933 dB FULL SCALE knob through all its positions and verify that the LED display on the 1935 reads correspondingly.

e. Connect the voltmeter and counter to the test point indicated and verify the voltage and frequency limits according to Table 4-7. A typical tone filter response is shown in Figure 4-13.

f. Turn the 1933 off and disconnect the 1935-0231 cable from the 1935.

g. With the 400-EL connected to TP2 and the dB FULL SCALE set for 80, check the voltage reading against Table 4-8; to determine which of the 3 voltage levels to use when setting B-R116 (Range Code Level).

h. Move the 400EL connection from TP2 to TP11; set the voltmeter to the 0.3-V range.

i. Adjust B-R116 for the correct reading as determined from Table 4-8.

j. Stop the 1935 and insert a regular cassette (P/N 1935-0430) and reset the tape counter to zero.

k. Set the 1935 to the record mode and rotate the dB FULL SCALE switch slowly through all of its positions before stopping the recorder.

l. Rewind the tape and place the 1935 in the playback mode. Note that the LED display sequences through as previously done during the record mode.

m. Stop the 1935.

Table 4-7

RANGE CODE CHECK LIMITS

Test Point	400EL Voltage	1192 Frequency (Hz)	Set 1933 Full-Scale
TP5 (10)	1.15 to 1.68	372-412	90
TP4 (20)	1.15 to 1.68	754-834	100
TP3 (40)	1.15 to 1.68	1513-1673	120
TP2 (80)	1.15 to 1.68	3031-3351	120

Table 4-8

RANGE CODE LEVEL

400EL Reading (Code 8)	Set B-TP11 Voltage to
1.15 to 1.3	196 mV
1.3 to 1.5	223 mV
1.5 to 1.68	254 mV

4.10.22 LED Display Intensity Adjustment.

a. Set the 1935 controls as follows:

dB FULL SCALE	AUTO
Range code (Channel B) Switch	ON
LED Display Switch	ON
PAUSE Lever	Engaged
RECORD-PLAY Lever	Engaged

b. Connect the 1806 (set for +DC) from circuit ground to WT61 (GN-BK wire located adjacent to the end of tape LED on the display board).

c. The LED display should be off and the 1806 reading +6.0 V dc.

d. Set the dB FULL SCALE switch to 40. The LED display should turn on.

e. Adjust B-R123 (LED Intensity) located on the top right-hand side of the main board for a reading of 5.4 V on the 1806. The actual voltage waveform at this point is a 6-V pulse having an adjusted duty ratio of 90%.

f. Stop the 1935.

4.10.23 End-of-Tape Sensor.

a. Insert a regular cassette (P/N 1935-0430). Set the 1935 to the FORWARD mode and wind the tape to its end. Enter the REWIND mode and rewind the tape about 3 or 4 units then enter the PLAY mode. When the tape reaches the end, the end-of-tape sensor switch located between the two tape heads should close.

b. The END of TAPE indicator should turn on, the motor stop and the recorder supply current should drop to approximately zero as noted on the 6215 supply meter.

4.11 INTERCONNECTING WIRE LIST.

The following lists are provided to enable service personnel to identify and locate test points and wires. In order to facilitate this, all interconnections are given names that bear some relation to the connection's function. Listings will enable the operator to locate a wire from the schematic or to find the function of a wire.

In the first listing, signal names are ordered alphabetically in the first column. Names are listed in pairs (except for some shields of cables), identifying both ends of the same wire. The second column identifies the termination of the wire. The third column lists the color of the wire or cable.

Interpretation of the signal destination (column 2) is as follows: wire ties (WT) are given as a number only, followed by the location of the wire tie, e.g., 75-C symbolizes the WT 75 located on etched-circuit board C. All other destinations are printed as they are listed in the schematic, with the addition of the assembly location.

Assemblies are identified as follows:

Prefix	Assembly	Part No.
A	Chassis	——
B	Main Board	1935-4710
C	Readout Board	1935-4740
D	Motor Speed Control Board	1935-4700
E	Preamplifier Board	1935-4720
F	Bias Board	1935-4750

Wire Colors are symbolized as follows:

BK	— black
BN	— brown
RD	— red
OR	— orange
YE	— yellow
GN	— green
BU	— blue
VT	— violet
GY	— gray
WH	— white

The second listing orders the destinations first alphabetically, then numerically, so that one may identify the signal wire color and name (which hints at the function).

Following this listing (par. 4.11.4) is a glossary of signal names to explain their meaning. In the above listings multiple wires having the same signal are indicated by a suffix number, e.g., FRUN1 and FRUN2. In the glossary below, such signal names are identified with a "____" in the place of the suffix number.

WIRING RUN LIST

SIGNAL	CONNECTION	COLOR
ADDIN	SO1-B-B	WH/VT
ADDIN	8-B	WH/VT
AHEDH	L1-BR-A	RIBN-BR
AHEDH	153-F	RIBN-BR
AHEDL	L1-BL-A	RIBN-RD
AHEDL	154-F	RIBN-RD
AMPTO	SO1-R-B	CAB-WH/RD
AMPTO	54-B	CAB-WH/RD
AMPTOS	AT3-B	SH-WH/RD
AMTP	50-B	CAB-YE
AMTP	85-E	CAB-YE
AMTPS	86-E	SH-YE
AMTRM	M1---C	OR/VT
AMTRM	77-C	OR/VT
AMTRP	M1-+-C	OR/GY
AMTRP	74-C	OR/GY
AOUT	J1-5-A	CAB-WH
AOUT	87-E	CAB-WH
AOUTS	J1-1-A	SH-WH
AOUTS	88-E	SH-WH
ARCIN1	J3-5-B	BR
ARCIN1	SO1-P-B	BR
ARCIN2	J3-5-B	CAB-BR
ARCIN2	21-B	CAB-BR
ARCIS	J3-1-B	SH-BR
ARCIS	22-B	SH-BR
ARCOU	26-B	CAB-BU
ARCOU	96-E	CAB-BU
ARCOUS	27-B	SH-BU
ARCOUS	97-E	SH-BU
AREAD	48-B	GY/RD
AREAD	75-C	GY/RD
ASIGH	93-E	CAB-GY(BK)
ASIGH	157-F	CAB-GY(BK)
ASIGL	95-E	CAB-GY(WH)
ASIGL	158-F	CAB-GY(WH)
ASIGS	94-E	SH-GY
ASIGS	159-F	SH-GY
BATM1	122-D	WH/BK
BATM1	151-A	WH/BK
BATM2	20-B	WH/BK
BATM2	151-A	WH/BK
BATM3	20-B	WH/BK
BATM3	82-E	WH-BK
BATM4	S2-3-A	YE/GN
BATM4	151-A	YE/GN
BATM5	S2-3-A	YE/GN
BATM5	67-C	YE/GN
BATM6	S2-202-B	WH/BK
BATM6	43-B	WH/BK
BATPL	S1-2R-A	OR/BU
BATPL	152-A	OR/BU
BCHIN	S1-3-B	RD/GN
BCHIN	39-B	RD/GN
BGAIN	S1-1-B	GY-BK
BGAIN	44-B	GY/BK
BHEDH	L1-TR-A	RIBN-BU
BHEDH	155-F	RIBN-BU
BHEDL	L1-TL-A	RIBN-GN
BHEDL	156-F	RIBN-GN
BIASH	114-B	CAB-WH/BU
BIASH	163-F	CAB-WH/BU
BIASS	113-B	SH-WH/BU
BIASS	164-F	SH-WH/BU
BMTPS1	1-B	SH-WH/GN
BMTPS2	99-E	SH-BK
BMTP1	3-B	CAB-WH/GN
BMTP1	53-B	CAB-WH/GN
BMTP2	3-B	CAB-BK
BMTP2	98-E	CAB-BK
BMTRM	M2---C	YE/BR
BMTRM	70-C	YE/BR

SIGNAL	CONNECTION	COLOR
BMTRP	M2-+-C	YE/BK
BMTRP	69-C	YE/BK
BOUT	J2-5-A	CAB-VT
BOUT	100-E	CAB-VT
BOUTS	J2-1-A	SH-VT
BOUTS	101-E	SH-VT
BRCIN	J1-5-B	CAB-OR
BRCIN	42-B	CAB/OR
BRCIS	J1-4-B	SH-OR
BRCIS	43-B	SH-OR
BRCOU	32-B	CAB-GN
BRCOU	105-E	CAB-GN
BRCOUS	33-B	SH-GN
BRCOUS	106-E	SH-GN
BREAD	49-B	VT/BK
BREAD	71-C	VT/BK
BSIGH	102-E	CAB-WH/VT(BK
BSIGH	160-F	CAB-WH/VT(BK
BSIGL	104-E	CAB-WH/VT(WH
BSIGL	161-F	CAB-WH/VT(WH
BSIGS	103-E	SH-WH/VT
BSIGS	162-F	SH-WH/VT
CARRY	14-B	BU/BR
CARRY	66-C	BU/BR
CDIN1	SO1-A-B	WH/GY
CDIN1	S2-103-B	WH/GY
CDIN2	SO1-D-B	WH/RD
CDIN2	S2-104-B	WH/RD
CDIN4	SO1-H-B	RD/BK
CDIN4	S2-207-B	RD/BK
CDIN8	SO1-L-B	WH/BU
CDIN8	S2-206-B	WH/BU
CDIS1	S2-103-B	WH/GY
CDIS1	7-B	WH/GY
CDIS2	S2-104-B	WH/RD
CDIS2	6-B	WH/RD
CDIS4	S2-207-B	RD/BK
CDIS4	5-B	RD/BK
CDIS8	S2-206-B	WH/BU
CDIS8	4-B	WH/BU
CDMKO	S1-5-B	GY-GN
CDMKO	47-B	GY/GN
CDOFF	23-B	BR
CDOFF	76-C	BR
CGP	37-B	RD/BN
CGP	111-E	RD/BR
CGR	38-B	RD/BU
CGR	109-E	RD/BU
CLOCK	15-B	GN/BK
CLOCK	61-C	GN/BK
DCOD1	13-B	BU/BK
DCOD1	65-C	BU/BK
DCOD2	12-B	BR/BK
DCOD2	64-C	BR/BK
DCOD4	11-B	WH/YE
DCOD4	63-C	WH/YE
DCOD8	10-B	WH/OR
DCOD8	62-C	WH/OR
ERASH	L2-BR-A	CAB-RD(BK)
ERASH	34-B	CAB-RD(BK)
ERASL	L2-BL-A	CAB-RD(WH)
ERASL	35-B	CAB-RD(WH)
ERASS	36-B	SH-RD
FRUN1	S2-2-A	WH/GN
FRUN1	18-B	WH/GN
FRUN2	18-B	WH/GN
FRUN2	121-D	WH/GN
GND1	J1-1-B	CWL-1
GND1	J1-4-B	CWL-1
GND2	S2-102-B	CWL-3
GND2	S2-202-B	CWL-3
GND3	AT3-B	GN

SIGNAL	CONNECTION	COLOR
GND3	J3-1-B	GN
GND4	AT3-B	GN
GND4	SO1-M-B	GN
GND5	J4-1-B	CWL-2
GND5	J4-4-B	CWL-2
JUMP3	S2-203-B	CWL-4
JUMP3	S2-206-B	CWL-4
JUMP4	S2-207-B	CWL-5
JUMP4	S2-211-B	CWL-5
LOUT1	SO1-C-B	VT/RD
LOUT1	28-B	VT/RD
LOUT2	SO1-F-B	VT/GY
LOUT2	29-B	VT/GY
LOUT4	SO1-K-B	OR/BK
LOUT4	30-B	OR/BK
LOUT8	SO1-N-B	OR/BR
LOUT8	31-B	OR/BN
MIKCD	J2-1-B	R2 (100K)
MIKCD	S1-6-B	R2(100K)
MKIN	J4-5-B	CAB-WH/GY
MKIN	40-B	CAB-WH/GY
MKSH	J4-4-B	SH-WH/GY
MKSH	41-B	SH-WH/GY
MKSWH	J2-5-B	GY/BR
MKSWH	45-B	GY/BR
MKSWL	J2-1-B	GY/BU
MKSWL	46-B	GY/BU
MOTM	B1---A	~~BU~~
MOTM	122-D	~~BU~~
MOTP	B1-+-A	RD
MOTP	123-D	RD
MPR1	52-B	GN
MPR1	110-E	GN
MPR2	52-B	GN
MPR2	127-D	GN
PLPR1	51-B	BU
PLPR1	115-B	BU
PLPR2	51-B	BU
PLPR2	108-E	BU
PLPR3	51-B	BU
PLPR3	126-D	BU
PLPR4	S1-2-B	VT
PLPR4	108-E	VT
QUIT1	S3-2-A	GN/BR
QUIT1	16-B	GN/BR
QUIT2	16-B	GN/BR
QUIT2	72-C	GN/BR
REMT1	17-B	GN/BU
REMT1	124-D	GN/BU
REMT2	SO1-E-B	GN/BU
REMT2	17-B	GN/BU
RMIN	25-B	YE
RMIN	112-E	YE
RPLUS	24-B	RD
RPLUS	107-E	RD
SHLD1	J1-1-A	R1-A(10)
SHLD1	TERM1-A	R1-A(10)
SHLD2	SO1-J-B	BK
SHLD2	TERM2-B	BK
SHLD3	TERM1-A	BK
SHLD3	TERM2-B	BK
SWBT1	S1-3F-A	GY
SWBT1	19-B	GY
SWBT2	S1-3F-A	GY
SWBT2	125-D	GY
SWBT3	9-B	GY
SWBT3	19-B	GY
SWBT4	9-B	GY
SWBT4	68-C	GY
TNOFF	S1-4-B	WH/BR
TNOFF	2-B	WH/BR

WIRING RUN LIST (Continued)

SIGNAL	CONNECTION	COLOR
AMPTOS	AT3-B	SH-WH/RD
GND3	AT3-B	GN
GND4	AT3-B	GN
MOTP	B1-+-A	RD
MOTM	B1--A	BU
AOUTS	J1-1-A	SH-WH
SHLD1	J1-1-A	R1-A(10)
GND1	J1-1-B	CWL-1
BRCIS	J1-4-B	SH-OR
GND1	J1-4-B	CWL-1
AOUT	J1-5-A	CAB-WH
BRCIN	J1-5-B	CAB-OR
BOUTS	J2-1-A	SH-VT
MIKCD	J2-1-B	R2 (100K)
MKSWL	J2-1-B	GY/BU
BOUT	J2-5-A	CAB-VT
MKSWH	J2-5-B	GY/BR
ARCIS	J3-1-B	SH-BR
GND3	J3-1-B	GN
ARCIN1	J3-5-B	BR
ARCIN2	J3-5-B	CAB-BR
GND5	J4-1-B	CWL-2
GND5	J4-4-B	CWL-2
MKSH	J4-4-B	SH-WH/GY
MKIN	J4-5-B	CAB-WH/GY
AHEDL	L1-BL-A	RIBN-RD
AHEDH	L1-BR-A	RIBN-BR
BHEDL	L1-TL-A	RIBN-GN
BHEDH	L1-TR-A	RIBN-BU
ERASL	L2-BL-A	CAB-RD(WH)
ERASH	L2-BR-A	CAB-RD(BK)
AMTRP	M1-+-C	OR/GY
AMTRM	M1--C	OR/VT
BMTRP	M2-+-C	YE/BK
BMTRM	M2--C	YE/BR
CDIN1	SO1-A-B	WH/GY
ADDIN	SO1-B-B	WH/VT
LOUT1	SO1-C-B	VT/RD
CDIN2	SO1-D-B	WH/RD
REMT2	SO1-E-B	GN/BU
LOUT2	SO1-F-B	VT/GY
CDIN4	SO1-H-B	RD/BK
SHLD2	SO1-J-B	BK
LOUT4	SO1-K-B	OR/BK
CDIN8	SO1-L-B	WH/BU
GND4	SO1-M-B	GN
LOUT8	SO1-N-B	OR/BR
ARCIN1	SO1-P-B	BR
AMPTO	SO1-R-B	CAB-WH/RD
BGAIN	S1-1-B	GY-BK
PLPR4	S1-2-B	VT
BATPL	S1-2R-A	OR/BU
BCHIN	S1-3-B	RD/GN
SWBT1	S1-3F-A	GY
SWBT2	S1-3F-A	GY
TNOFF	S1-4-B	WH/BR
CDMKO	S1-5-B	GY-GN
MIKCD	S1-6-B	R2(100K)
GND2	S2-102-B	CWL-3
CDIN1	S2-103-B	WH/GY
CDIS1	S2-103-B	WH/GY
CDIN2	S2-104-B	WH/RD
CDIS2	S2-104-B	WH/RD
FRUN1	S2-2-A	WH/GN
BATM6	S2-202-B	WH/BK
GND2	S2-202-B	CWL-3
JUMP3	S2-203-B	CWL-4
CDIN8	S2-206-B	WH/BU
CDIS8	S2-206-B	WH/BU
JUMP3	S2-206-B	CWL-4
CDIN4	S2-207-B	RD/BK
CDIS4	S2-207-B	RD/BK

SIGNAL	CONNECTION	COLOR
JUMP4	S2-207-B	CWL-5
JUMP4	S2-211-B	CWL-5
BATM4	S2-3-A	YE/GN
BATM5	S2-3-A	YE/GN
QUIT1	S3-2-A	GN/BR
SHLD1	TERM1-A	R1-A(10)
SHLD3	TERM1-A	BK
SHLD2	TERM2-B	BK
SHLD3	TERM2-B	BK
BMTPS1	1-B	SH-WH/GN
TNOFF	2-B	WH/BR
BMTP1	3-B	CAB-WH/GN
BMTP2	3-B	CAB-BK
CDIS8	4-B	WH/BU
CDIS4	5-B	RD/BK
CDIS2	6-B	WH/RD
CDIS1	7-B	WH/GY
ADDIN	8-B	WH/VT
SWBT3	9-B	GY
SWBT4	9-B	GY
DCOD8	10-B	WH/OR
DCOD4	11-B	WH/YE
DCOD2	12-B	BR/BK
DCOD1	13-B	BU/BK
CARRY	14-B	BU/BR
CLOCK	15-B	GN/BK
QUIT1	16-B	GN/BR
QUIT2	16-B	GN/BR
REMT1	17-B	GN/BU
REMT2	17-B	GN/BU
FRUN1	18-B	WH/GN
FRUN2	18-B	WH/GN
SWBT1	19-B	GY
SWBT3	19-B	GY
BATM2	20-B	WH/BK
BATM3	20-B	WH/BK
ARCIN2	21-B	CAB-BR
ARCIS	22-B	SH-BR
CDOFF	23-B	BR
RPLUS	24-B	RD
RMIN	25-B	YE
ARCOU	26-B	CAB-BU
ARCOUS	27-B	SH-BU
LOUT1	28-B	VT/RD
LOUT2	29-B	VT/GY
LOUT4	30-B	OR/BK
LOUT8	31-B	OR/BN
BRCOU	32-B	CAB-GN
BRCOUS	33-B	SH-GN
ERASH	34-B	CAB-RD(BK)
ERASL	35-B	CAB-RD(WH)
ERASS	36-B	SH-RD
CGP	37-B	RD/BN
CGR	38-B	RD/BU
BCHIN	39-B	RD/GN
MKIN	40-B	CAB-WH/GY
MKSH	41-B	SH-WH/GY
BRCIN	42-B	CAB/OR
BATM6	43-B	WH/BK
BRCIS	43-B	SH-OR
BGAIN	44-B	GY/BK
MKSWH	45-B	GY/BR
MKSWL	46-B	GY/BU
CDMKO	47-B	GY/GN
AREAD	48-B	GY/RD
BREAD	49-B	VT/BK
AMTP	50-B	CAB-YE
PLPR1	51-B	BU
PLPR2	51-B	BU
PLPR3	51-B	BU
MPR1	52-B	GN
MPR2	52-B	GN

SIGNAL	CONNECTION	COLOR
BMTP1	53-B	CAB-WH/GN
AMPTO	54-B	CAB-WH/RD
CLOCK	61-C	GN/BK
DCOD8	62-C	WH/OR
DCOD4	63-C	WH/YE
DCOD2	64-C	BR/BK
DCOD1	65-C	BU/BK
CARRY	66-C	BU/BR
BATM5	67-C	YE/GN
SWBT4	68-C	GY
BMTRP	69-C	YE/BK
BMTRM	70-C	YE/BR
BREAD	71-C	VT/BK
QUIT2	72-C	GN/BR
AMTRP	74-C	OR/GY
AREAD	75-C	GY/RD
CDOFF	76-C	BR
AMTRM	77-C	OR/VT
BATM3	82-E	WH-BK
AMTP	85-E	CAB-YE
AMTPS	86-E	SH-YE
AOUT	87-E	CAB-WH
AOUTS	88-E	SH-WH
ASIGH	93-E	CAB-GY(BK)
ASIGS	94-E	SH-GY
ASIGL	95-E	CAB-GY(WH)
ARCOU	96-E	CAB-BU
ARCOUS	97-E	SH-BU
BMTP2	98-E	CAB-BK
BMTPS2	99-E	SH-BK
BOUT	100-E	CAB-VT
BOUTS	101-E	SH-VT
BSIGH	102-E	CAB-WH/VT(BK
BSIGS	103-E	SH-WH/VT
BSIGL	104-E	CAB-WH/VT(WH
BRCOU	105-E	CAB-GN
BRCOUS	106-E	SH-GN
RPLUS	107-E	RD
PLPR2	108-E	BU
PLPR4	108-E	VT
CGR	109-E	RD/BU
MPR1	110-E	GN
CGP	111-E	RD/BK
RMIN	112-E	YE
BIASS	113-B	SH-WH/BU
BIASH	114-B	CAB-WH/BU
PLPR1	115-B	BU
FRUN2	121-D	WH/GN
BATM1	122-D	WH/BK
MOTM	122-D	BU
MOTP	123-D	RD
REMT1	124-D	GN/BU
SWBT2	125-D	GY
PLPR3	126-D	BU
MPR2	127-D	GN
BATM1	151-A	WH/BK
BATM2	151-A	WH/BK
BATM4	151-A	YE/GN
BATPL	152-A	OR/BU
AHEDH	153-F	RIBN-BR
AHEDL	154-F	RIBN-RD
BHEDH	155-F	RIBN-BU
BHEDL	156-F	RIBN-GN
ASIGH	157-F	CAB-GY(BK)
ASIGL	158-F	CAB-GY(WH)
ASIGS	159-F	SH-GY
BSIGH	160-F	CAB-WH/VT(BK
BSIGL	161-F	CAB-WH/VT(WH
BSIGS	162-F	SH-WH/VT
BIASH	163-F	CAB-WH/BU
BIASS	164-F	SH-WH/BU

SIGNAL INDEX

Mnemonic	Function
ADDIN	add signal input
AHEDH	channel A head high
AHEDL	channel A lead low
AMPTO	channel A auxiliary output
AMPTOS	channel A auxiliary shield
AMTP	channel A playback
AMTPS	channel A playback shield
AMTRM	channel A meter minus
AMTRP	channel A meter plus
AOUT	channel A m
AOUT	channel A output
AOUTS	channel A output shield
ARCIN_	channel A record input
ARCIS	channel A record input shield
ARCOU	channel A record output
ARCOUS	channel A record output shield
AREAD	channel A meter signal (read)
ASIGH	channel A signal high (signal to bias board)
ASIGL	channel A signal low (signal to bias board)
AISGS	channel A signal shield
BATM_	battery minus
BATPL	battery plus
BCHIN	channel B input
BGAIN	channel B gain
BHEDH	channel B head high
BHEDL	channel B head low
BIASH	bias high
BIASS	bias shield
BMTPS__	channel B playback shield
BMTP	channel B playback
BMTRM	channel B meter minus
BMTRP	channel B meter plus
BOUT	channel B output
BOUTS	channel B shield
BRCIN	channel B record input
RICIS	channel B shield
BRCOU	channel B record output

Mnemonic	Function
BRCOUS	channel B shield
BREAD	channel B meter (read)
BSIGH	channel B signal high
BSIGL	channel B signal low
BSIGS	channel B shield
CARRY	code carry
CDIN__	code input
CDIS__	code signal
CDMKO	mike code
CDOFF	code off
CGP	control gate playback
CGR	control gate record
CLOCK	readout clock
DCOD__	decode line
ERASH	erase high
ERASL	erase low
FRUN__	fast run
GND__	ground
JUMP__	wire jumper
LOUT__	logic out
MIKCD	mike code
MKIN	mike input
MKSH	mike shield
MKSWH	mike switch high
MKSWL	mike switch low
MOTM	motor minus
MOTP	motor plus
MPR__	minus power
PLPR__	plus power
QUIT__	quit (end of tape)
REMT__	remote
RMIN	record minus
RPLUS	record plus
SHLD__	shield
SWBT__	switched battery
TNOFF	turnoff (code)

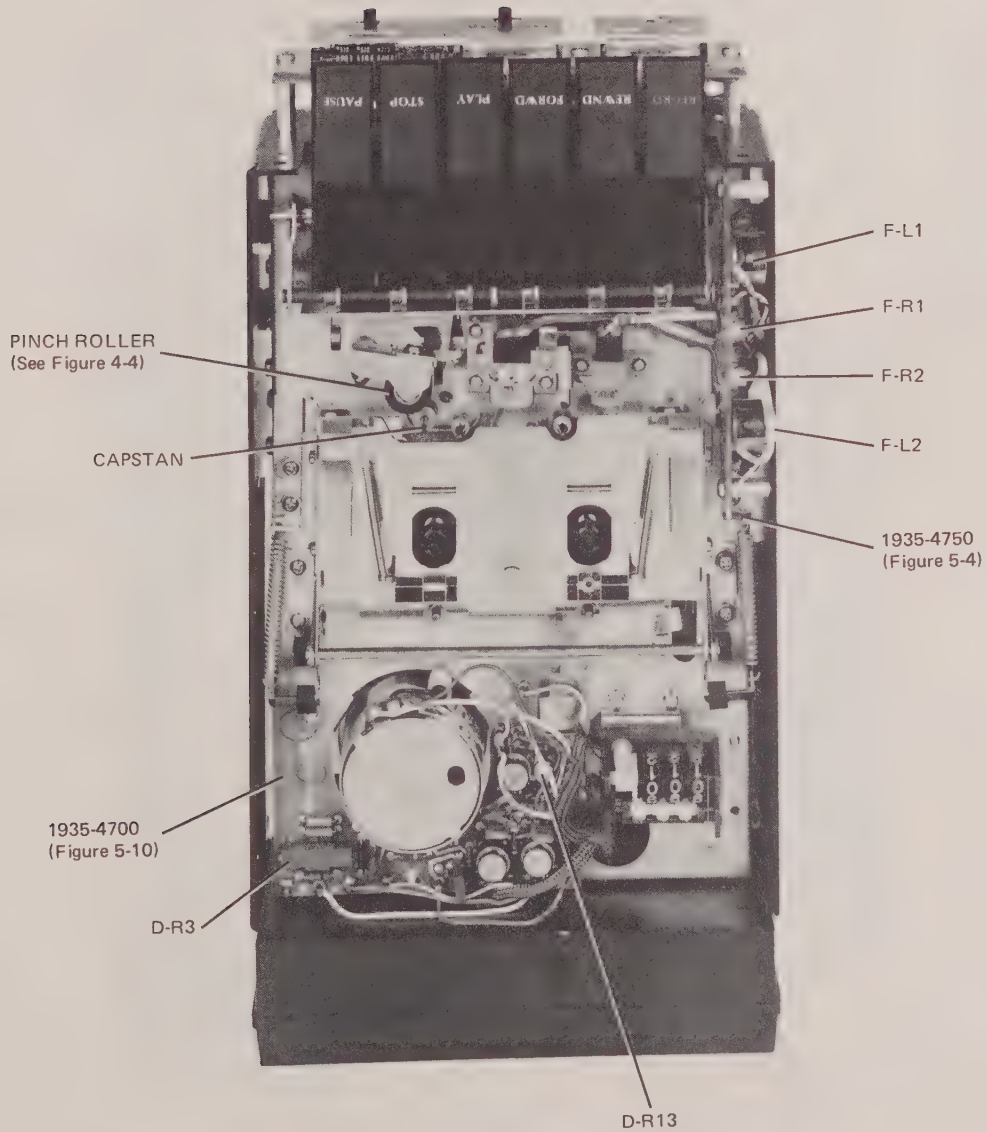

Figure 4-14. Top interior view.

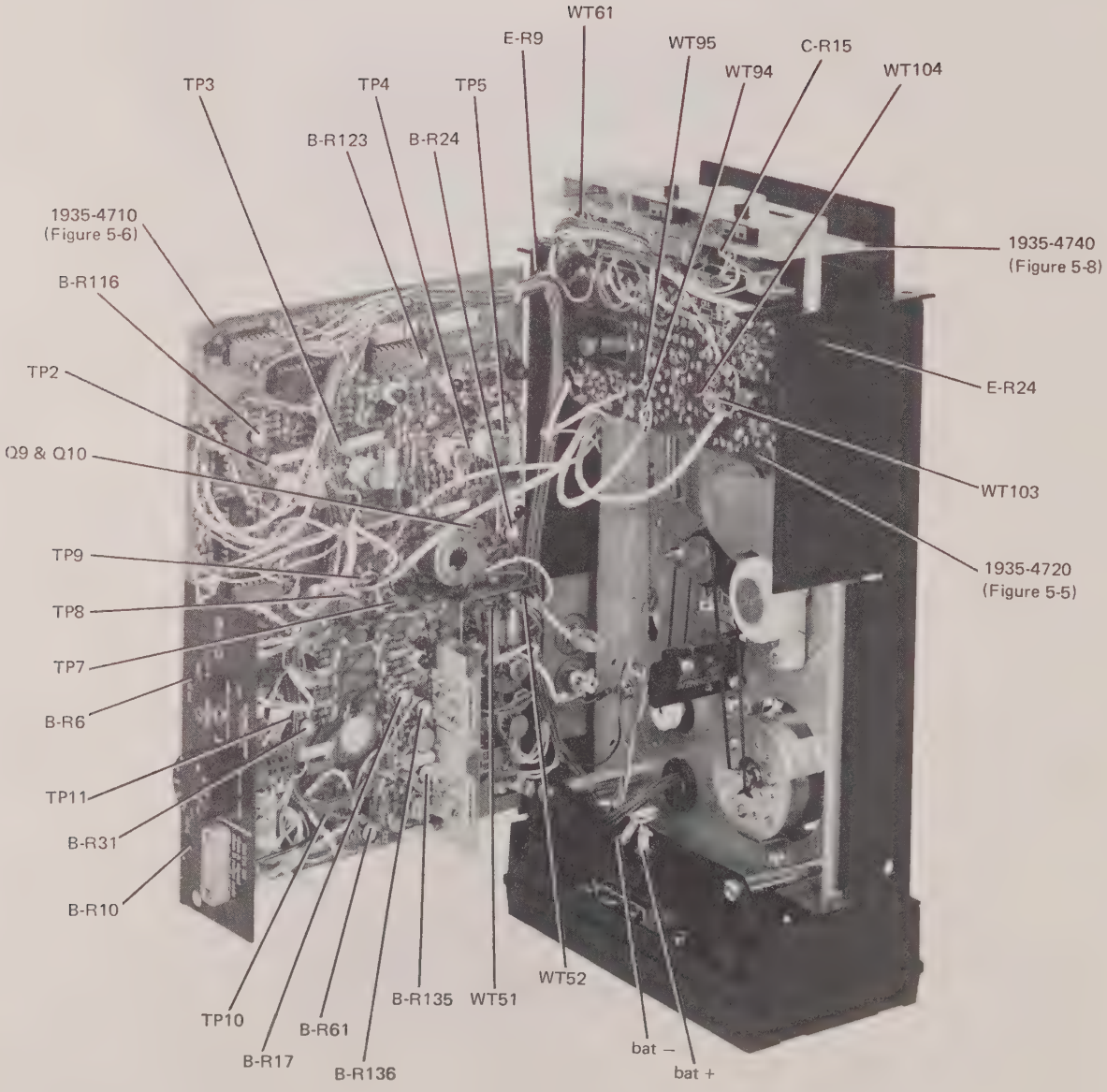

Figure 4-15. Bottom interior view.

Parts Lists and Diagrams—Section 5

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Record/Playback Head Board—F (P/N 1935-4750)	5-7
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Interconnecting Cable (P/N 1935-0230)	5-13

NOTE

The parts list, etched-board assembly diagram and schematic diagram for a specific circuit are located on adjacent pages.

Each reference designator used in our schematic diagrams and circuit descriptions includes an initial letter, before a hyphen, to identify the subassembly. The numeric portion of each designator is generally shorter than would be the case if a block of numbers were assigned to each subassembly. A new designation WT (wire-tie point) replaces the customary AT (anchor terminal). The letter before the hyphen may be omitted only if clearly understood, as within a subassembly schematic diagram.
Examples: B-R8 = B board, resistor 8; D-WT2 = D board, wire-tie point 2, CR6 on the V schematic is a shortened form of V-CR6 = V board, diode 6. The instrument may contain A-R1, B-R1, C-R1, and D-R1, etc.

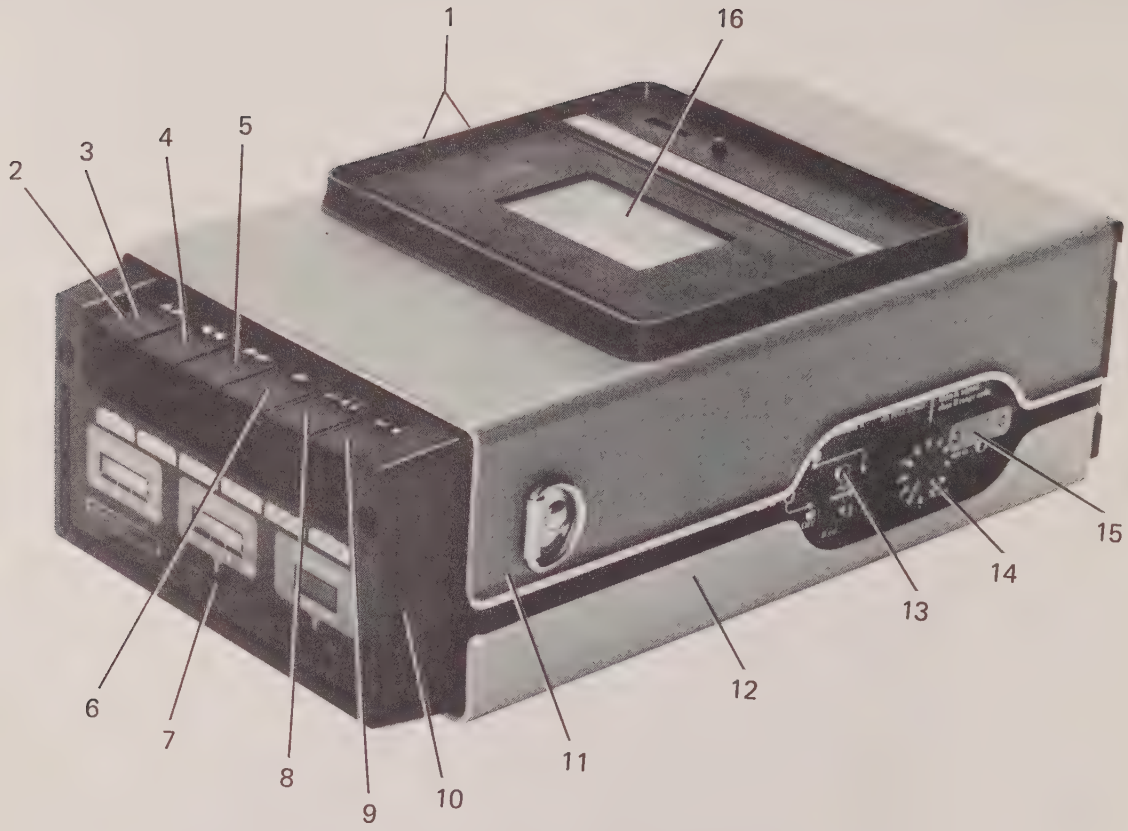


Figure 5-1. Mechanical parts identification — view 1.

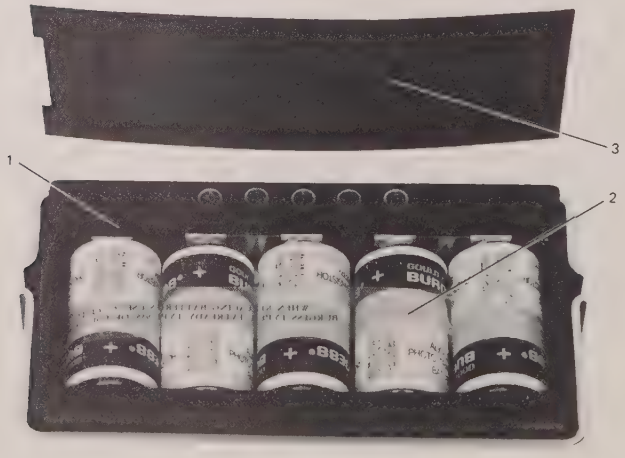


Figure 5-2. Mechanical parts identification — view 2.

MECHANICAL PARTS LIST

Fig 5-1 Ref	Qnt	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
1	5	Conn, Miniature, Jack, A-J2, B-J1, 2, 3 OUTPUT, 600 Ω A B, CHAN B, AUX IN, VOICE INTERRUPT, CHAN A AUX IN	4260-1110	24368	TR-2A	
2	6	Lever Knob, Black	1935-7040	24655	1935-7040	
3	1	Label Marked RECORD	1935-7041	24655	1935-7041	
4	1	Label Marked REWIND	1935-7042	24655	1935-7042	
5	1	Label Marked FORWD	1935-7043	24655	1935-7043	
6	1	Label Marked PLAY	1935-7044	24655	1935-7044	
7	3	Slide Switch, 2 Pos., DPDT, (B-S1, C-S1, 2) RANGE CODE ON/OFF, dB FULL SCALE ON/OFF, BAT CHECK/CHAN B	7910-0470	05568	23-021-118	
8	1	Label Marked STOP	1935-7045	24655	1935-7045	
9	1	Label Marked PAUSE	1935-7046	24655	1935-7046	
10	1	Panel Molding Asm.	1935-1110	24655	1935-1110	
11	1	Bezel Asm.	1935-2020	24655	1935-2020	
12	1	Bottom Cover Asm.	1935-1030	24655	1935-1030	
13	1	Conn, Miniature, Jack, B-J4 CHANNEL B, VOICE INTERRUPT	4260-1170	24368	#42A	
14	1	Knob Asm dB FULL SCALE, AUTO, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140	1935-1020	24655	1935-1020	
15	1	Socket, B-S01 DATA IN/OUT, CHAN A B	4230-5010	95238	SM14-20SS	
16	1	Cassette 30 Min.	1935-0430	24655	1935-0430	
MISCELLANEOUS						
	1	Tape Guide and Sensor Asm.	1935-2100	24655	1935-2100	

MECHANICAL PARTS LIST

Fig Ref	Qnt	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
1	1	Battery Compartment Asm. complete	1935-2000	24655	1935-2000	
2	5	Battery "C" Cell	8410-1500	09823	ALI	
3	1	Battery Compartment Cover	1935-8240	24655	1935-8240	

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
		Board E – (P/N 1935-4720)			
CAPACITORS					
C1	Tantalum, 68 μF, ±20%, 15 V	4450-5615	80183	150D686X0015R2	
C2	Mylar, .0113 μF, ±1%, 100 V	4860-7903	84411	663UW, .0113 μF, ±1%	
C3	Tantalum, 1.0 μF, ±20%, 35 V	4450-4300	56289	150D105X0035A2	5910-726-5003
C4	Cer. Disc., 51 pF, ±5%	4404-0515	09302	831, 51 pF, ±5%	
C6	Tantalum, 68 μF, ±15 V	4450-5615	80183	150D686X0015R2	
C7	Mylar, .0113 μF, ±1%, 100 V	4860-7903	84411	663UW, .0113 μF, ±1%	
C8	Tantalum, 1.0 μF, ±20%, 35 V	4450-4300	56289	150D105X0035A2	5910-726-5003
C9	Cer. Disc., 51 pF, ±5%	4404-0515	09392	831, 51 pF, ±5%	
C13 and C14	Ceramic, .01 μF, Disc +80-20% 100 V	4401-3100	09302	805, .01 μF, +80-20%	
C15 and C16	Cer. Disc., 33 pF, ±5%	4404-0335	09302	831, 33 pF, ±5%	
DIODES					
CR1 and CR2	Type MPD-200	6082-1033	06751	MPD-200	
CR3 and CR4	Type 1N957B	6083-1038	28959	1N957B	
INTEGRATED CIRCUITS					
U1 and U2	Type LM301A	5432-1004	18080	LM301A	
RESISTORS					
R1	Comp., 220 kΩ, ±5%, 1/4 W	6099-4225	00912	BB, 220 kΩ, ±5%	
R2	Film, 487 Ω, ±1%, 1/8 W	6250-0487	12928	CEA, 487 Ω, ±1%	
R3	Film, 10.5 kΩ, ±1%, 1/8 W	6250-2105	12928	CEA, 10.5 kΩ, ±1%	5905-882-0037
R4	Film, 210 kΩ, ±1%, 1/8 W	6250-3210	12928	CEA, 210 kΩ, ±1%	5905-847-3422
R5	Comp., 9.1 kΩ, ±5%, 1/4 W	6099-2915	00912	BB, 9.1 kΩ, ±5%	
R6	Comp., 33 kΩ, ±5%, 1/4 W	6099-3335	00912	BB, 33 kΩ, ±5%	
R7	Comp., 470 kΩ, ±5%, 1/4 W	6099-4475	00912	BB, 470 kΩ, ±5%	
R8	Comp., 39 kΩ, ±5%, 1/4 W	6099-3395	00912	BB, 39 kΩ, ±5%	
R9	Pot. Cermet, 50 kΩ, ±20%	6049-0320	03920	3389S-1-503	
R10	Comp., 10 kΩ, ±5%, 1/4 W	6099-3105	00912	BB, 10 kΩ, ±5%	
R11	Film, 1 kΩ, ±1%, 1/8 W	6250-1100	12928	CEA, 1 kΩ, ±1%	5905-581-6915
R12	Film, 100 kΩ, ±1%, 1/8 W	6250-3100	12928	CEA, 100 kΩ, ±1%	5905-577-6743
R13	Film, 604 Ω, ±1%, 1/8 W	6250-0604	12928	CEA, 604 Ω, ±1%	
R14 and R15	Comp., 10 Ω, ±5%, 1/4 W	6099-0105	00912	BB, 10 kΩ, ±5%	
R16	Comp., 220 kΩ, ±5%, 1/4 W	6099-4225	00912	BB, 220 kΩ, ±5%	
R17	Film, 487 Ω, ±1%, 1/8 W	6250-0487	12928	CEA, 487 Ω, ±1%	
R18	Film, 10.5 kΩ, ±1%, 1/8 W	6250-2105	12928	CEA, 10.5 kΩ, ±1%	5905-882-0037
R19	Film, 210 kΩ, ±1%, 1/8 W	6250-3210	12928	CEA, 210 kΩ, ±1%	5905-847-3422
R20	Comp., 9.1 kΩ, ±5%, 1/4 W	6099-2915	00912	BB, 9.1 kΩ, ±5%	
R21	Comp., 33 kΩ, ±5%, 1/4 W	6099-3335	00912	BB, 33 kΩ, ±5%	
R22	Comp., 470 kΩ, ±5%, 1/4 W	6099-4475	00912	BB, 470 kΩ, ±5%	
R23	Comp., 39 kΩ, ±5%, 1/4 W	6099-3395	00912	BB, 39 kΩ, ±5%	
R24	Pot. Cermet, 50 kΩ, ±20%	6049-0320	03920	3389S-1-503	
R25	Comp., 10 kΩ, ±5%, 1/4 W	6099-3105	00912	BB, 10 kΩ, ±5%	
R26	Film, 1 kΩ, ±1%, 1/8 W	6250-1100	12928	CEA, 1 kΩ, ±1%	5905-581-6915
R27	Film, 100 kΩ, ±1%, 1/8 W	6250-3100	12928	CEA, 100 kΩ, ±1%	5905-577-6743
R28	Film, 604 Ω, ±1%, 1/8 W	6250-0604	12928	CEA, 604 Ω, ±1%	
R29 and R30	Comp., 1 MΩ, ±5%, 1/4 W	6099-5105	00912	CB, 1 MΩ, ±5%	
R33 and R34	Comp., 1000 Ω, ±5%, 1/4 W	6099-2105	00912	CB, 1 kΩ, ±5%	
SWITCH					
S1	Pushbutton, Mult (6 Pos) Cont	7880-2009	05264	PB-1	
		7540-3473	02384	X8059-7G1	

ELECTRICAL PARTS LIST (cont)

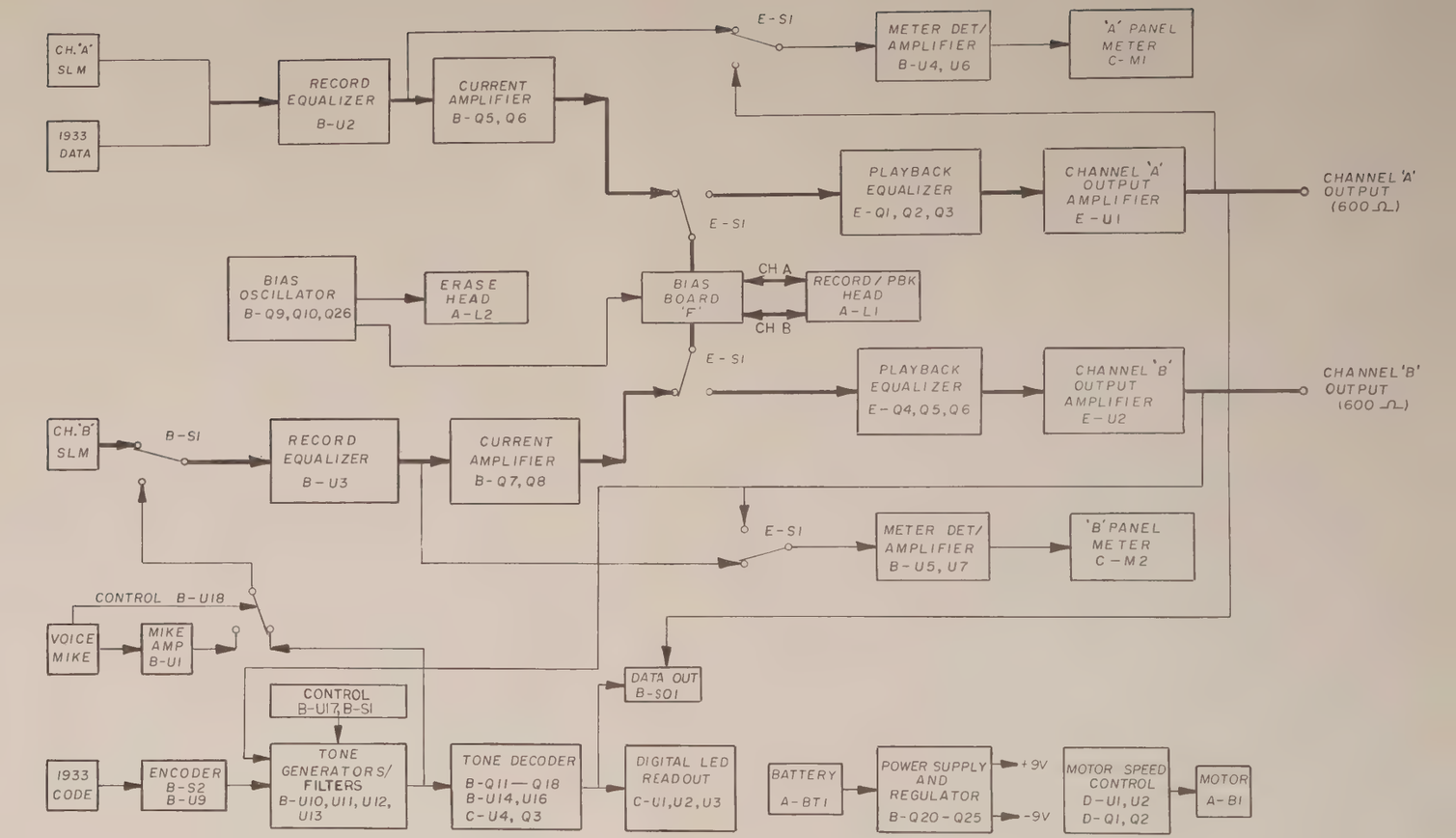
Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
TRANSISTORS		Board E – (P/N 1935-4720) Cont.			
Q1 and Q2	Type 2N4250	8210-1135	07263	2N4250	
Q3	Type 2N6008	8210-1083	06704	2N6008	
Q4 and Q5	Type 2N4250	8210-1135	07263	2N4250	
Q6	Type 2N6008	8210-1083	06704	2N6008	

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
CAPACITORS		Board F – (P/N 1935-4750)			
C1 and C2	Mica, 200 pF, ±5%, 300 V	4700-0507	16902	CM05, 200 pF, ±5%	
C3 and C4	Mica, 270 pF, ±5%, 500 V	4700-0528	08944	DM15 (4CK) 270 pF, ±5%	
CONNECTORS					
	Min 4 Cont., Female	4220-1260	18947	105020	
INDUCTOR ASM:					
L1 and L2	11.6mH	1935-2051	24655	1935-2051	
RESISTORS					
R1 and R2	Pot., 100 kΩ, ±20%	6049-0112	03920	3006P-1-101	

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
BATTERIES		Chassis Mounted			
	"C" Cell	8410-1500	09823	ALI	
JACKS					
B-J1 thru B-J3		4260-1110	82389	TR-2A	
B-J4		4260-1170	24368	42A	
SOCKETS					
B-S01		4230-5010	95238	SM14-20SS	
SWITCHES					
B-S1		7910-0470	05568	23-021-118	
B-S2		7890-5610	19120	7890-5610	



NOTES:
- HEAVY LINE IS MAIN SIGNAL PATH.
- SWITCH E-S1 SHOWN IN RECORD POSITION.
- 'A' PREFIX PARTS ON CHASSIS (FRAME).
- 'B' PREFIX PARTS ON MAIN 1935-4710 BOARD.
- 'C' PREFIX PARTS ON READOUT BOARD.
- 'D' PREFIX PARTS ON MOTOR SPEED CONTROL 1935-4700 BOARD.
- 'E' PREFIX PARTS ON PLAYBACK 1935-4720 BOARD.
- 'F' PREFIX PARTS ON BIAS 1935-4750 BOARD.

Figure 5-3. Block diagram.

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
	Board B – (P/N 1935-4710)				
CAPACITORS					
C1	Ceramic, 470 pF, ±5%, 500 V	4404-1475	03932	831, 470 pF, ±5%	
C2	Ceramic, .1 μF, ±20%, 50 V	4400-2050	03932	8131-M050-651-104M	
C3	Ceramic, 30 pF, ±5%, 500 V	4404-0305	03932	831, 30 pF, ±5%	
C4 and C5	Ceramic, 1 μF, ±20%, 50 V	4400-2070	05286	300-050-601-105M	
C6	Ceramic, 10 pF, ±10%, 500 V	4404-0108	03932	831, 10 pF, ±10%	
C7	Mylar, .0031μF, ±2%, 100 V	4860-7337	24512	663UW, .0031 μF, 1%	
C8	Mylar, .068 μF, ±10%, 100 V	4860-7870	24512	663UW, .068 μF, ±10%	
C9	Tantalum, 1.0 μF, ±20%, 35 V	4450-4300	56289	150D105X0035A2	5910-726-5003
C10	Tantalum, 4.7 μF, ±20%, 10 V	4450-4700	07536	4450-4700	
C11	Tantalum, 1.0 μF, ±20%, 35 V	4450-4300	56289	150D105X0035A2	5910-726-5003
C12	Ceramic, 100 pF, ±5%, 500 V	4404-1105	03932	831, 100 pF ±5%	
C13	Tantalum, 1.0 μF, ±20%, 35 V	4450-4300	56289	150D105X0035A2	5910-726-5003
C14	Ceramic, .1 μF, ±20%, 50 V	4400-2050	09392	8131-M050-651-104M	
C15	Tantalum, 1.0 μF, ±20%, 35 V	4450-4300	56289	150D105X0035A2	5910-726-5003
C16	Ceramic, 10 pF, ±10%, 500 V	4404-0108	03932	831, 10 pF ±10%	
C17	Mylar, .0031 μF, ±2%, 100 V	4860-7337	24512	663UW, .0031 μF, ±1%	
C18	Mylar, .068 μF, ±10%, 100 V	4860-7870	24512	663UW, .068 μF, ±10%	
C19	Tantalum, 1.0 μF, ±20%, 35 V	4450-4300	56289	150D105X0035A2	5910-726-5003
C20	Tantalum, 4.7 μF, ±20%, 10 V	4450-4700	07536	4450-4700	
C21	Tantalum, 1.0 μF, ±20%, 35 V	4450-4300	56289	150D105X0035A2	5910-726-5003
C22	Ceramic, 100 pF, ±5%, 500 V	4404-1105	03932	831, 100 pF, ±5%	
C23	Ceramic, 1270 pF, ±5%, 100 V	4420-1040	09392	8141, 1270 pF, ±5% 100 V	
C24	Ceramic, .1 μF, ±20%, 50 V	4400-2050	09392	8131-M050-651-104M	
C26	Ceramic, .1 μF, ±20%, 50 V	4400-2050	09392	8131-M050-651-104M	
C27	Mylar, .047 μF, ±10%, 50 V	4860-9473	08891	230BIC473K	
C28	Ceramic, .1 μF, ±20%, 50 V	4400-2050	09392	8131-M050-651-104M	
C29	Mylar, .047 μF, ±10%, 50 V	4860-9473	08891	230BIC473K	
C30	Tantalum, 1.0 μF, ±20%, 35 V	4450-4300	56289	150D105X0035A2	5910-726-5003
C31	Ceramic, .1 μF, ±20%, 50 V	4400-2050	09392	8131-M050-651-104M	
C32	Mica, 2370 pF, ±2%, 500 V	4590-0871	08944	DM20(4CR) 2370 pF ±2%	
C33 and C34	Ceramic, .1 μF, ±20%, 50 V	4400-2050	09392	8131-M050-651-104M	
C35	Tantalum, 6.8 μF, ±20%, 6 V	4450-4800	56289	150D685X0010A2	5910-936-1332
C36 and C37	Mylar, .01 μF, ±2%, 100 V	4860-7650	24512	663UW, .01 μF, ±2%	
C38 and C39	Ceramic, .1 μF, ±20%, 50 V	4400-2050	09392	8131-M050-651-104M	
C40	Tantalum, 6.8 μF, ±20%, 6 V	4450-4800	56289	150D685X0010A2	5910-936-1332
C41 and C42	Mylar, .01 μF, ±2%, 100 V	4860-7650	24512	663UW, .01 μF, ±2%	
C43 and C44	Ceramic, .1 μF, ±20%, 50 V	4400-2050	09392	8131-M050-651-104M	
C45	Tantalum, 6.8 μF, ±20%, 6 V	4450-4800	56289	150D685X0010A2	5910-936-1332
C46 and C47	Mylar, .01 μF, ±2%, 100 V	4860-7650	24512	663UW, .01 μF, ±2%	
C48 and C49	Ceramic, .1 μF, ±20%, 50 V	4400-2050	09392	8131-M050-651-104M	
C50	Tantalum, 6.8 μF, ±20%, 6 V	4450-4800	56289	150D685X0010A2	5910-936-1332
C51 and C52	Mylar, .01 μF, ±2%, 100 V	4860-7650	24512	663UW, .01 μF, ±2%	

ELECTRICAL PARTS LIST (cont)

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
CAPACITORS (continued)					
C53 and C54	Mylar, .027 μF, ±5%, 100 V	4860-7862	24512	663UW, .027 μF, ±5%	
C55 and C56	Ceramic, 1000 pF, ±5%, 500 V	4405-2105	03932	801, 1000 pF, ±5%	
C57 and C58	Ceramic, .01 μF, +80-20%, 100 V	4401-3100	03932	805, .01 μF, +80-20%	
C59	Tantalum, 10 μF, ±20%, 20 V	4450-5100	56289	150D106X0020B2	5910-855-6343
C60 and C61	Ceramic, .1 μF, ±20%, 50 V	4400-2070	05286	300-050-601-105M	
C62 and C63	Tantalum, 300 μF, ±20%, 10 V	4450-5724	24454	69F933, 300 μF, ±20%	
C66 and C67	Ceramic, 180 pF, ±5%, 500 V	4404-1185	03932	831, 180 pF, ±5%	
C68 thru C70	Ceramic, 220 pF, ±5%, 500 V	4404-1225	03932	831, 220 pF, ±5%	
DIODES					
CR1 thru CR3	Type 1N3604	6082-1001	25440	1N3604	
CR4	Type 1N34A(S)	6082-1003	58854	1N34A(S)	5961-170-4430
CR5 thru CR23	Type 1N3604	6082-1001	25440	1N3604	
CR24	Type 1N935	6083-1026	07910	1N935	5960-760-9599
CR25 thru CR30	Type 1N455	6082-1010	07910	1N455	5960-877-8255
CR32 and CR33	Type 1N957B	6083-1038	28959	1N957B	
CR34 and CR35	Type 1N3604	6082-1001	25440	1N3604	
INTEGRATED CIRCUITS					
U1	Type LM308H	5432-1030	18080	LM308H	
U2 and U3	Type LM301A	5432-1004	18080	LM301A	
U4 and U5	Type 1933-0830	1933-0830	24655	1933-0830	
U6 and U7	Type μA776	5432-1039	93916	μA776	
U8	Type CD4016AE	5431-7003	06704	CD4016AE	
U9	Type CD4008AE	5431-7002	06704	CD4008AE	
U10 thru U13	Type μA776	5432-1039	93916	μA776	
U14	Type CD4008AE	5431-7002	06704	CD4008AE	
U15 and U16	Type CD4011AE	5431-7000	06704	CD4011AE	
U17 and U18	Type CD4016AE	5431-7003	06704	CD4016AE	

ELECTRICAL PARTS LIST (cont)

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
INDUCTORS					
L1 and L2	33000 μH	4300-6398	72259	Wee Ductor 10,000 μH	
L5 and L6	56 μH	4300-6390	99800	3500, 56 μH	5950-410-3879
JACKS					
	PC, .025 Lead	4260-1292	00032	2-331272-5	
RESISTORS					
R1	Comp., 100 kΩ, 5%, 1/4 W	6099-4105	00912	CB, 100 kΩ, ±5%	
R3 and R4	Comp., 200 kΩ, ±5%, 1/4 W	6099-4205	00912	CB, 200 kΩ, ±5%	
R5	Comp., 1 MΩ, ±5%, 1/4 W	6099-5105	00912	CB, 1 MΩ, ±5%	
R6	Pot., 25 kΩ, ±20%	6049-0430	03920	3389S-1-253	
R7	Film, 3.01 kΩ, ±1%, 1/8 W	6250-1301	12928	CEA, 3.01 kΩ, ±1%	5905-702-5974
R8 and R9	Comp., 1 MΩ, ±5%, 1/4 W	6099-5105	00912	CB, 1 MΩ, ±5%	
R10	Pot., 25 kΩ, ±20%	6049-0430	03920	3389S-1-253	
R11	Film, 3.01 kΩ, ±1%, 1/8 W	6250-1301	12928	CEA, 3.01 kΩ, ±1%	5905-702-5974
R12	Film, 5.49 kΩ, ±1%, 1/8 W	6250-1549	12928	CEA, 5.49 kΩ, ±1%	
R13	Film, 750 Ω, ±1%, 1/8 W	6250-0750	12928	CEA, 750 Ω, ±1%	5905-676-8776
R14	Film, 22.1 kΩ, ±1%, 1/8 W	6250-2221	12928	CEA, 22.1 kΩ, ±1%	
R15	Film, 100 kΩ, ±1%, 1/8 W	6250-3100	12928	CEA, 100 kΩ, ±1%	
R16	Comp., 22 kΩ, ±5%, 1/4 W	6099-3225	00912	CB, 22 kΩ, ±5%	
R17	Pot., 10 kΩ, ±20%	6049-0109	03920	3329H-1-103	
R18	Comp., 22 kΩ, ±5%, 1/4 W	6099-3225	00912	CB, 22 kΩ, ±5%	
R19	Comp., 62 kΩ, ±5%, 1/4 W	6099-3625	00912	CB, 62 kΩ, ±5%	
R20	Comp., 2.0 kΩ, ±5%, 1/4 W	6099-2205	00912	CB, 2.0 kΩ, ±5%	
R21	Comp., 220 kΩ, ±5%, 1/4 W	6099-4225	00912	CB, 220 kΩ, ±5%	
R22	Comp., 62 kΩ, ±5%, 1/4 W	6099-3625	00912	CB, 62 kΩ, ±5%	
R23	Comp., 2.0 kΩ, ±5%, 1/4 W	6099-2205	00912	CB, 2.0 kΩ, ±5%	
R24	Pot., 200 kΩ, ±20%	6049-0113	03920	3329H-1-204	
R25	Comp., 1 MΩ, ±5%, 1/4 W	6099-5105	00912	CB, 1 MΩ, ±5%	
R26	Film, 5.49 kΩ, ±1%, 1/8 W	6250-1549	12928	CEA, 5.49 kΩ, ±1%	
R27	Film, 750 Ω, ±1%, 1/8 W	6250-0750	12928	CEA, 750 Ω, ±1%	5905-676-8776
R28	Film, 22.1 kΩ, ±1%, 1/8 W	6250-2221	12928	CEA, 22.1 kΩ, ±1%	
R29	Film, 100 kΩ, ±1%, 1/8 W	6250-3100	12928	CEA, 100 kΩ, ±1%	
R30	Comp., 22 kΩ, ±5%, 1/4 W	6099-3225	00912	CB, 22 kΩ, ±5%	
R31	Pot., 10 kΩ, ±20%	6049-0109	03920	3329H-1-103	
R32	Comp., 22 kΩ, ±5%, 1/4 W	6099-3225	00912	CB, 22 kΩ, ±5%	
R33	Comp., 62 kΩ, ±5%, 1/4 W	6099-3625	00912	CB, 62 kΩ, ±5%	
R34	Comp., 2.0 kΩ, ±5%, 1/4 W	6099-2205	00912	CB, 2.0 kΩ, ±5%	
R35	Comp., 220 kΩ, ±5%, 1/4 W	6099-4225	00912	CB, 220 kΩ, ±5%	
R36	Comp., 62 kΩ, ±5%, 1/4 W	6099-3625	00912	CB, 62 kΩ, ±5%	
R37	Comp., 2.0 kΩ, ±5%, 1/4 W	6099-2205	00912	CB, 2.0 kΩ, ±5%	
R39	Film, 71.5 kΩ, ±1%, 1/8 W	6250-2715	12928	CEA, 71.5 kΩ, ±1%	

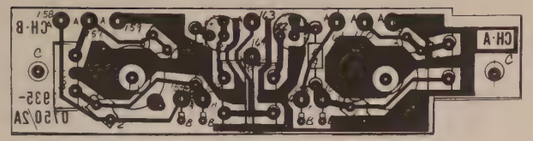


Figure 5-4. Etched-circuit diagram, R/P head board — F (P/N 1935-4750).

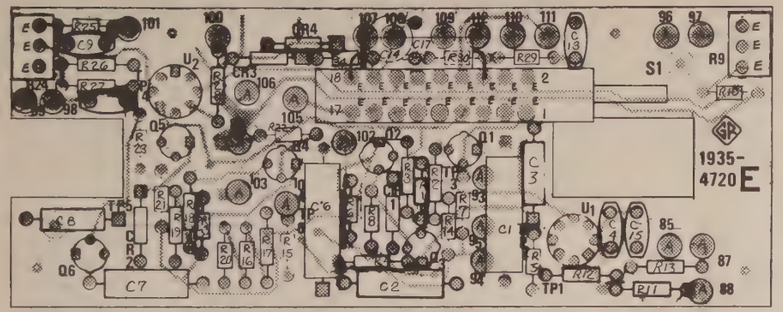


Figure 5-5. Etched-circuit diagram, preamp board — E (P/N 1935-4720).

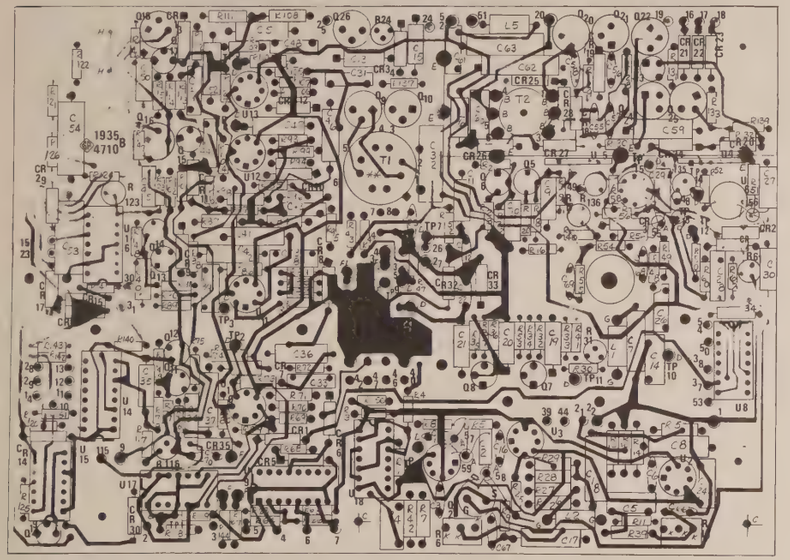


Figure 5-6. Etched-circuit diagram, main board — B (P/N 1935-4710).

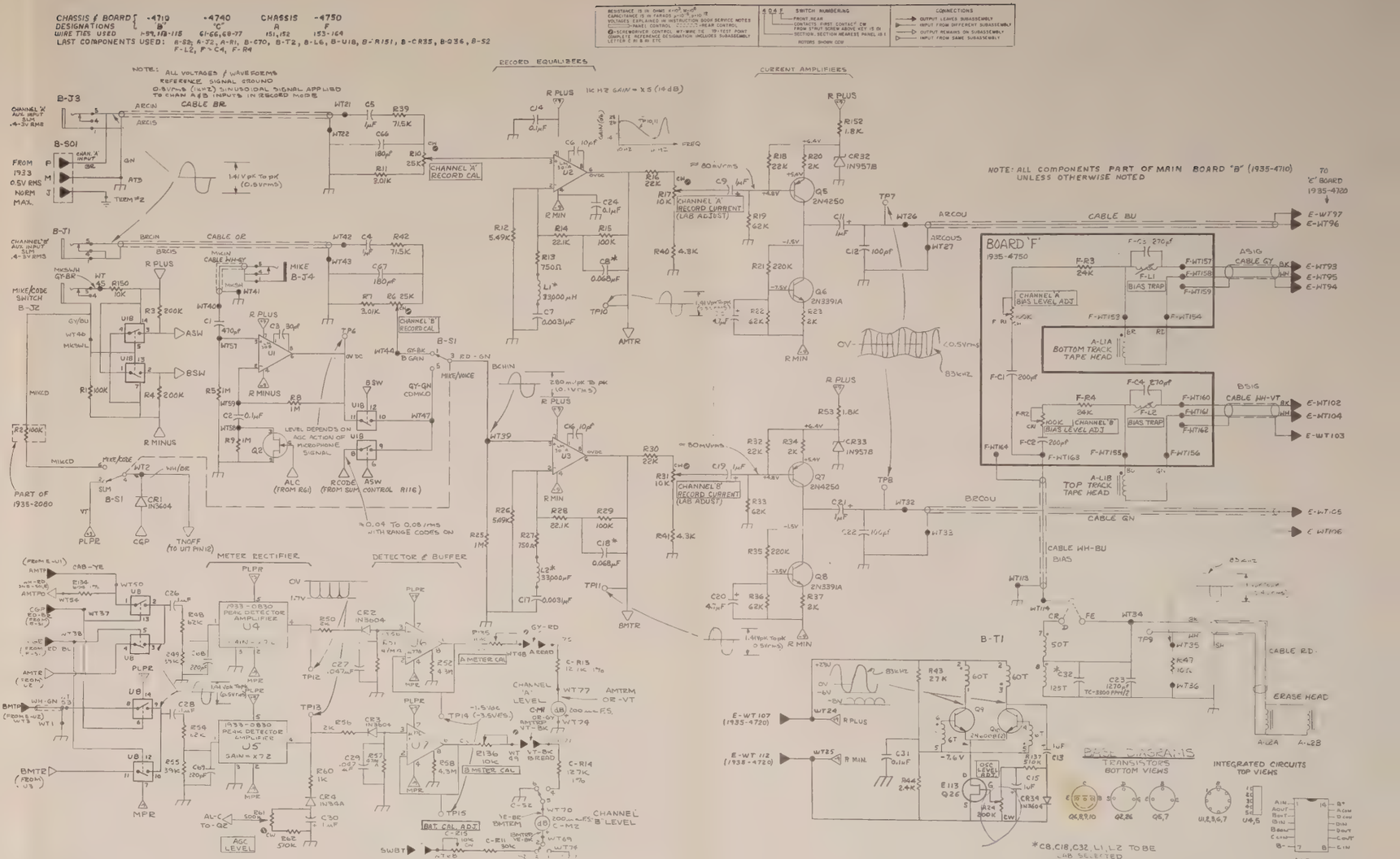

CHASSIS & BOARD DESIGNATIONS -4710 'B' -4740 'C' CHASSIS -4750 'F'
WIRE TIES USED 1-89,118-118 61-66,68-77 151,152 153-164
LAST COMPONENTS USED: B-82, A-72, A-R1, B-C70, B-T2, B-L6, B-U18, B-R151, B-CR35, B-Q36, B-S2 F-L2, F-C4, F-R4
NOTE: ALL VOLTAGES & WAVEFORMS REFERENCE SIGNAL GROUND
0.5VRMS (1KHZ) SINUSOIDAL SIGNAL APPLIED TO CHAN A & B INPUTS IN RECORD MODE
RECORD EQUALIZERS
CURRENT AMPLIFIERS
NOTE: ALL COMPONENTS PART OF MAIN BOARD "B" (1935-4710) UNLESS OTHERWISE NOTED
BOARD 'F' 1935-4750
CHANNEL 'A' BIAS LEVEL ADJ
CHANNEL 'B' BIAS LEVEL ADJ
A-L1A BOTTOM TRACK TAPE HEAD
A-L1B TOP TRACK TAPE HEAD
BIAS TRAP
CHANNEL 'A' RECORD CURRENT (LAB ADJUST)
CHANNEL 'B' RECORD CURRENT (LAB ADJUST)
METER RECTIFIER
DETECTOR & BUFFER
BAT CAL ADJ
CHANNEL 'A' LEVEL
CHANNEL 'B' LEVEL
TRANSISTORS BOTTOM VIEWS
INTEGRATED CIRCUITS TOP VIEWS
*C8,C18,C32 L1,L2 TO BE LAB SELECTED

Figure 5-7. Schematic diagram for analog circuits.

ELECTRICAL PARTS LIST (cont)

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No	Fed Stock No.
		Board B – (P/N 1935-4710) Cont.			
RESISTORS (continued)					
R40 and					
R41	Comp., 4.3 kΩ, ±5%, 1/4 W	6099-2435	00912	CB, 4.3 kΩ, ±5%	
R42	Film, 71.5 kΩ, ±1%, 1/8 W	6250-2715	12928	CEA, 71.5 kΩ, ±1%	
R43	Comp., 27 kΩ, ±5%, 1/4 W	6099-3275	00912	CB, 27 kΩ, ±5%	
R44	Comp., 2.4 kΩ, ±5%, 1/4 W	6099-2245	00912	CB, 2.4 kΩ, ±5%, 1/4 W	
R47	Comp., 10 Ω, ±5%, 1/4 W	6099-0105	00912	CB, 10 Ω, ±5%	
R48	Comp., 62 kΩ, ±5%, 1/4 W	6099-3625	00912	CB, 62 kΩ, ±5%	
R49	Comp., 39 kΩ, ±5%, 1/4 W	6099-3395	00912	CB, 39 kΩ, ±5%	
R50	Comp., 2.0 kΩ, ±5%, 1/4 W	6099-2205	00912	CB, 2.0 kΩ, ±5%	
R51	Comp., 47 MΩ, ±5%, 1/4 W	6099-6475	00912	CB, 47 MΩ, ±5%	
R52	Comp., 4.3 MΩ, ±5%, 1/4 W	6099-5435	00912	CB, 4.3 MΩ, ±5%	
R53	Comp., 1.8 kΩ, ±5%, 1/4 W	6099-2185	00912	CB, 1.8 kΩ, ±5%	
R54	Comp., 62 kΩ, ±5%, 1/4 W	6099-3625	00912	CB, 62 kΩ, ±5%	
R55	Comp., 39 kΩ, ±5%, 1/4 W	6099-3395	00912	CB, 39 kΩ, ±5%	
R56	Comp., 2.0 kΩ, ±5%, 1/4 W	6099-2205	00912	CB, 2.0 kΩ, ±5%	
R57	Comp., 47 MΩ, ±5%, 1/4 W	6099-6475	00912	CB, 47 MΩ, ±5%	
R58	Comp., 4.3 MΩ, ±5%, 1/4 W	6099-5435	00912	CB, 43 MΩ, ±5%	
R60	Comp., 1.0 kΩ, ±5%, 1/4 W	6099-2105	00912	CB, 1.0 kΩ, ±5%	
R61	Pot., 500 kΩ, ±30%	6049-0114	03920	3329H-1-504	
R62	Comp., 510 kΩ, ±5%, 1/4 W	6099-4515	00912	CB, 510 kΩ, ±5%	
R63 thru					
R68	Comp., 200 kΩ, ±5%, 1/4 W	6099-4205	00912	CB, 200 kΩ, ±5%	
R69 and					
R70	Comp., 10 kΩ, ±5%, 1/4 W	6099-3105	00912	CB, 10 kΩ, ±5%	
R71	Film, 1.27 kΩ, ±1%, 1/8 W	6250-1127	12928	CEA, 1.27 kΩ, ±1%	5905-721-0281
R72	Comp., 43 kΩ, ±5%, 1/4 W	6099-3435	00912	CB, 43 kΩ, ±5%	
R73	Film, 71.5 kΩ, ±1%, 1/8 W	6250-2715	12928	CEA, 71.5 kΩ, ±1%	
R74	Film, 348 Ω, ±1%, 1/8 W	6250-0348	12928	CEA, 348 Ω, ±1%	
R75	Comp., 10 kΩ, ±5%, 1/4 W	6099-3105	00912	CB, 10 kΩ, ±5%	
R76	Comp., 91 kΩ, ±5%, 1/4 W	6099-3915	00912	CB, 91 kΩ, ±5%	
R77	Comp., 10 kΩ, ±5%, 1/4 W	6099-3105	00912	CB, 10 kΩ, ±5%	
R78	Comp., 100 kΩ, ±5%, 1/4 W	6099-4105	00912	CB, 100 kΩ, ±5%	
R79	Comp., 1 MΩ, ±5%, 1/4 W	6099-5105	00912	CB, 1 MΩ, ±5%	
R80	Comp., 820 kΩ, ±5%, 1/4 W	6099-4825	00912	CB, 820 kΩ, ±5%	
R81	Comp., 1 MΩ, ±5%, 1/4 W	6099-5105	00912	CB, 1 MΩ, ±5%	
R82 and					
R83	Comp., 10 kΩ, ±5%, 1/4 W	6099-3105	00912	CB, 10 kΩ, ±5%	
R84	Film, 1.27 kΩ, ±1%, 1/8 W	6250-1127	12928	CEA, 1.27 kΩ, ±1%	5905-721-0281
R85	Comp., 43 kΩ, ±5%, 1/4 W	6099-3435	00912	CB, 43 kΩ, ±5%	
R86	Film, 143 kΩ, ±1%, 1/8 W	6250-3143	12928	CEA, 143 kΩ, ±1%	
R87	Film, 698 Ω, ±1%, 1/8 W	6250-0698	12928	CEA, 698 Ω, ±1%	5905-824-8535
R88	Comp., 10 kΩ, ±5%, 1/4 W	6099-3105	00912	CB, 10 kΩ, ±5%	
R89	Comp., 91 kΩ, ±5%, 1/4 W	6099-3915	00912	CB, 91 kΩ, ±5%	
R90	Comp., 10 kΩ, ±5%, 1/4 W	6099-3105	00912	CB, 10 kΩ, ±5%	
R91	Comp., 100 kΩ, ±5%, 1/4 W	6099-4105	00912	CB, 100 kΩ, ±5%	
R92	Comp., 820 kΩ, ±5%, 1/4 W	6099-4825	00912	CB, 820 kΩ, ±5%	
R93	Comp., 1 MΩ, ±5%, 1/4 W	6099-5105	00912	CB, 1 MΩ, ±5%	
R94 and					
R95	Comp., 10 kΩ, ±5%, 1/4 W	6099-3105	00912	CB, 10 kΩ, ±5%	
R96	Film, 1.27 kΩ, ±1%, 1/8 W	6250-1127	12928	CEA, 1.27 kΩ, ±1%	5905-721-0281
R97	Comp., 43 kΩ, ±5%, 1/4 W	6099-3435	00912	CB, 43 kΩ, ±5%	
R98	Film, 287 kΩ, ±1/8 W	6250-3287	12928	CEA, 287 kΩ, ±1%	
R99	Film, 1.40 kΩ, ±1%, 1/8 W	6250-1140	12928	CEA, 1.40 kΩ, ±1%	
R100	Comp., 10 kΩ, ±5%, 1/4 W	6099-3105	00912	CB, 10 kΩ, ±5%	

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
RESISTORS (continued)					
R101	Comp., 91 kΩ, ±5%, 1/4 W	6099-3915	00912	CB, 91 kΩ, ±5%	
R102	Comp., 15 kΩ, ±5%, 1/4 W	6099-3155	00912	CB, 15 kΩ, ±5%	
R103	Comp., 100 kΩ, ±5%, 1/4 W	6099-4105	00912	CB, 100 kΩ, ±5%	
R104	Comp., 820 kΩ, ±5%, 1/4 W	6099-4825	00912	CB, 820 kΩ, ±5%	
R105	Comp., 1 MΩ, ±5%, 1/4 W	6099-5105	00912	CB, 1 MΩ, ±5%	
R106 and					
R107	Comp., 10 kΩ, ±5%, 1/4 W	6099-3105	00912	CB, 10 kΩ, ±5%	
R108	Film, 1.27 kΩ, ±1%, 1/8 W	6250-1127	12928	CEA, 1.27 kΩ, ±1%	5905-721-0281
R109	Comp., 43 kΩ, ±5%, 1/4 W	6099-3435	00912	CB, 43 kΩ, ±5%	
R110	Film, 590 kΩ, ±1%, 1/8 W	6250-3590	12928	CEA, 590 kΩ, ±1%	
R111	Film, 2.8 kΩ, ±1%, 1/8 W	6250-1280	12928	CEA, 2.8 kΩ, ±1%	
R112	Comp., 15 kΩ, ±5%, 1/4 W	6099-3155	00912	CB, 15 kΩ, ±5%	
R113	Comp., 91 kΩ, ±5%, 1/4 W	6099-3915	00912	CB, 91 kΩ, ±5%	
R114	Comp., 15 kΩ, ±5%, 1/4 W	6099-3155	00912	CB, 15 kΩ, ±5%	
R115	Comp., 100 kΩ, ±5%, 1/4 W	6099-4105	00912	CB, 100 kΩ, ±5%	
R116	Pot., 2 kΩ, ±20%	6049-0107	91474	597035	
R117	Comp., 2.4 kΩ, ±5%, 1/4 W	6099-2245	00912	CB, 2.4 kΩ, ±5%	
R118	Comp., 15 kΩ, ±5%, 1/4 W	6099-3155	00912	CB, 15 kΩ, ±5%	
R119	Comp., 1.0 kΩ, ±5%, 1/4 W	6099-2105	00912	CB, 1.0 kΩ, ±5%	
R120	Comp., 200 kΩ, ±5%, 1/4 W	6099-4205	00912	CB, 200 kΩ, ±5%	
R121	Comp., 300 kΩ, ±5%, 1/4 W	6099-4305	00912	CB, 300 kΩ, ±5%	
R122	Comp., 130 kΩ, ±5%, 1/4 W	6099-4135	00912	CB, 130 kΩ, ±5%	
R123	Pot., 200 kΩ, ±20%	6049-0113	03920	3329H-1-204	
R124	Comp., 18 kΩ, ±5%, 1/4 W	6099-3185	00912	CB, 18 kΩ, ±5%	
R125	Comp., 51 kΩ, ±5%, 1/4 W	6099-3515	00912	CB, 51 kΩ, ±5%	
R126	Comp., 200 kΩ, ±5%, 1/4 W	6099-4205	00912	CB, 200 kΩ, ±5%	
R127	Comp., 820 kΩ, ±5%, 1/4 W	6099-4825	00912	CB, 820 kΩ, ±5%	
R128 and					
R129	Comp., 1.5 kΩ, ±5%, 1/4 W	6099-2155	00912	CB, 1.5 kΩ, ±5%	
R130	Comp., 470 Ω, ±5%, 1/4 W	6099-1475	00912	CB, 470 Ω, ±5%	
R131 and					
R132	Comp., 15 kΩ, ±5%, 1/4 W	6099-3155	00912	CB, 15 kΩ, ±5%	
R133	Comp., 24 kΩ, ±5%, 1/4 W	6099-3245	00912	CB, 24 kΩ, ±5%	
R134	Film, 604 Ω, ±1%, 1/8 W	6250-0604	12928	CEA, 604 Ω, ±1%	
R135 and					
R136	Pot., 10 kΩ, ±20%	6049-0109	03920	3329H-1-103	
R137	Comp., 510 kΩ, ±5%, 1/4 W	6099-4515	00912	CB, 510 kΩ, ±5%	
R139	Comp., 5.1 kΩ, ±5%, 1/4 W	6099-2515	00912	CB, 5.1 kΩ, ±5%	
R140 thru					
R143	Comp., 100 kΩ, ±5%, 1/4 W	6099-4105	00912	CB, 100 kΩ, ±5%	
R144	Comp., 200 kΩ, ±5%, 1/4 W	6099-4205	00912	CB, 200 kΩ, ±5%	
R146 thru					
R149	Comp., 100 kΩ, ±5%, 1/4 W	6099-4105	00912	CB, 100 kΩ, ±5%	
R150	Comp., 15 kΩ, ±5%, 1/4 W	6099-3155	00912	CB, 15 kΩ, ±5%	
R151	Comp., 4.3 kΩ, ±5%, 1/4 W	6099-2515	00912	CB, 5.1 kΩ, ±5%	
R152	Comp., 1.8 kΩ, ±5%, 1/4 W	6099-2185	00912	CB, 1.8 kΩ, ±5%	

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
TRANSFORMER ASM					
T1	(Bias Osc)	1935-2061	24655	1935-2061	
T2	(Power)	1935-2071	24655	1935-2071	
TRANSISTORS					
Q2	Type E101	8210-1187	23120	E101	
Q5	Type 2N4250	8210-1135	07263	2N4250	
Q6	Type 2N3391A	8210-1092	24454	2N3391A	5961-985-9077
Q7	Type 2N4250	8210-1135	07263	2N4250	
Q8	Type 3391A	8210-1092	24454	2N3391A	5961-985-9077
Q9 and					
Q10	Type 2N6008	8210-1083	06704	2N6008	
Q11	Type 2N3391A	8210-1092	24454	2N3391A	5961-985-9077
Q12	Type 2N4250	8210-1135	07263	2N4250	
Q13	Type 2N3391A	8210-1092	24454	2N3391A	5961-985-9077
Q14	Type 2N4250	8210-1135	07263	2N4250	
Q15	Type 2N3391A	8210-1092	24454	2N3391A	5961-985-9077
Q16	Type 2N4250	8210-1135	07263	2N4250	
Q17	Type 2N3391A	8210-1092	24454	2N3391A	5961-985-9077
Q18	Type 2N4250	8210-1135	07263	2N4250	
Q19	Type 2N3391A	8210-1092	24454	2N3391A	5961-985-9077
Q20 and					
Q21	Type 2N1308	8210-1024	96214	2N1308	
Q22	Type 2N2218	8210-1028	96214	2N2218	5960-059-4464
Q23	Type 2N3391A	8210-1092	24454	2N3391A	5961-985-9077
Q24 and					
Q25	Type 2N4250	8210-1135	07263	2N4250	
Q26	Type E-113	8210-1229	23120	E-113	

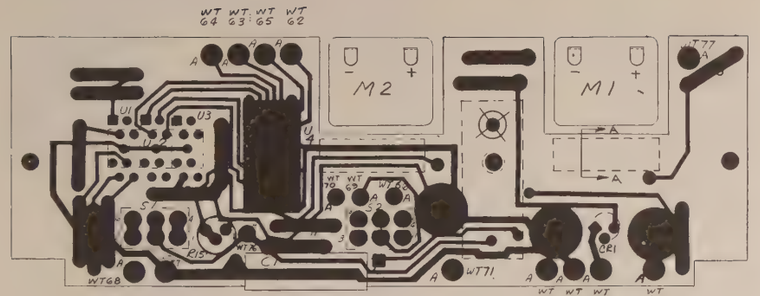


Figure 5-8. Etched-circuit diagram, readout display board — C (P/N 1935-4740).

NOTE: *Orientation:* Viewed from parts side. *Part number:* Refer to caption. *Symbolism:* Outline area = part; ckt pattern = parts side. *Pins:* Square pad in ckt pattern = collector, I-C pin 1, cathode (of diode), or + end (of capacitor).

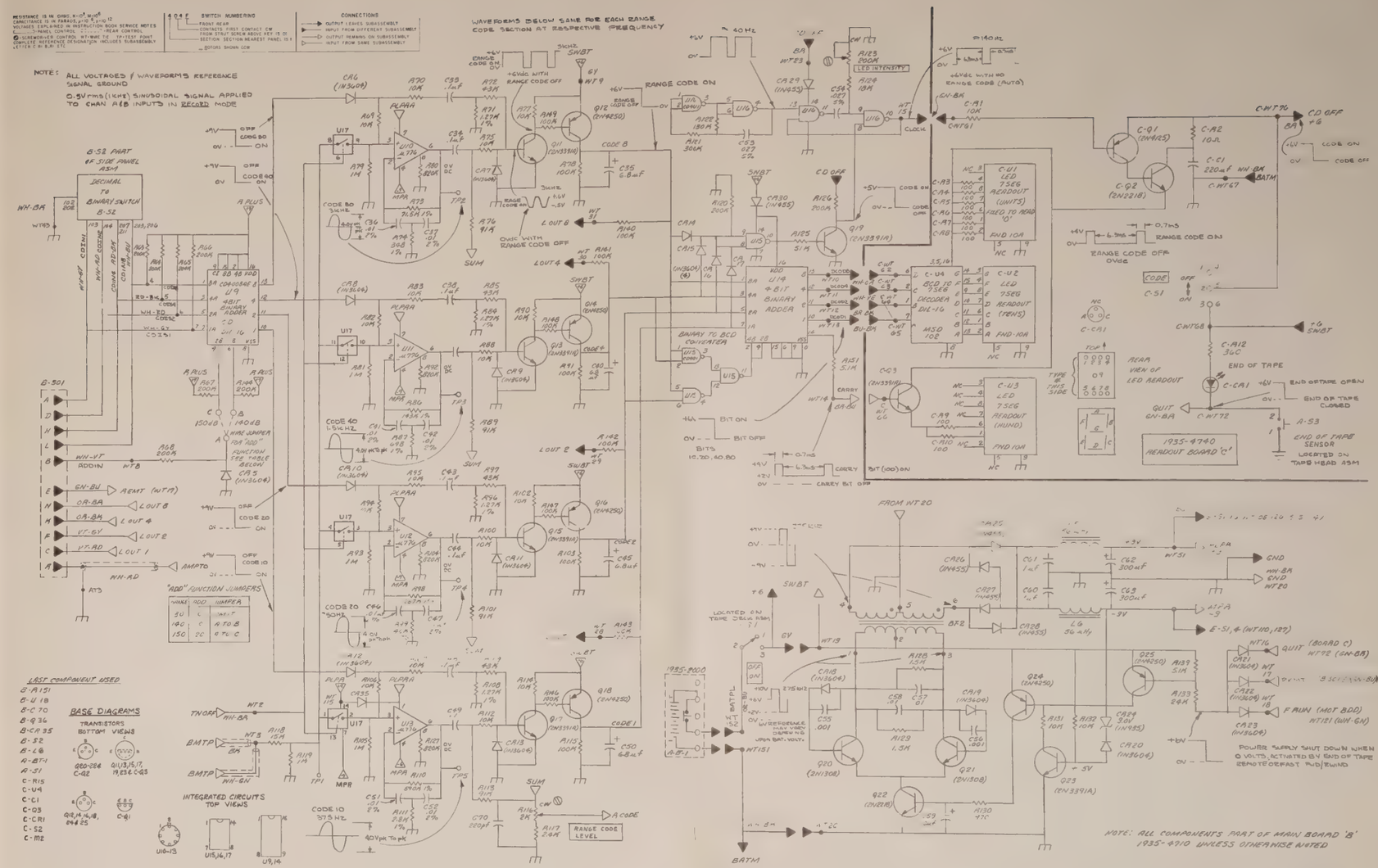


Figure 5-9. Schematic diagram for digital logic circuits and power supply.

ELECTRICAL PARTS LIST

Board C – (P/N 1935-4740)

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
CAPACITORS					
C1	Elect., 220 μF, ±20%, 10 V	4450-5706	12954	D220D10M1	
DIODES					
CR1	Type FLV101	6084-1100	22368	FLV101	
INTEGRATED CIRCUITS					
U1 thru U3	Type FND10A	5437-1200	09664	FND10A	
U4	Type 5431-9644	5431-9644	22368	5431-9644	
METERS					
M1 and M2	Type 200μa	5730-1436	17744	TS-10, 200 μa	
RESISTORS					
R1	Comp., 10 kΩ, ±5%, 1/4 W	6099-3105	00912	CB, 10 kΩ, ±5%	
R2	Comp., 10 Ω, ±5%, 1/4 W	6099-0105	00912	CB, 10 Ω, ±5%	
R3 thru R10	Comp., 100 Ω, ±5%, 1/4 W	6099-1105	00912	CB, 100 Ω, ±5%	
R11	Comp., 30 kΩ, ±5%, 1/4 W	6099-3305	00912	CB, 30 kΩ, ±5%	
R12	Comp., 360 Ω, ±5%, 1/4 W	6099-1365	00912	CB, 360 Ω, ±5%	
R13 and R14	Comp., 17.8 kΩ, ±1%, 1/8 W	6250-2178	12928	CEA, 17.8 kΩ, ±1%	
R15	Pot, 10 kΩ	6049-0109	03920	3329H-1-103	
SWITCHES					
S1 and S2	Slide	7910-0470	71744	23-021-118	
TRANSISTORS					
Q1	Type 2N4125	8210-1125	04713	2N4125	
Q2	Type 2N2218	8210-1028	96214	2N2218	5960-059-4464
Q3	Type 2N3391A	8210-1092	24454	2N3391A	5961-985-9077

ELECTRICAL PARTS LIST

Board D – (P/N 1935-4700)

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
CAPACITORS					
C1	Ceramic, .001 μF ±5%, 500 V	4405-2105	09392	801, 1000 μF ±5%	
C2	Ceramic, 1 μF ±20%, 50 V	4400-2070	05286	300-050-601-105M	
C3	Ceramic, .01 μF +80-20% 100 V	4401-3100	09392	805, .01 μF +80-20%	
C4	Ceramic, 1 μF ±20%, 50 V	4400-2070	05286	300-050-601-105M	
C5 and C6	Ceramic, .1 μF ±20%, 50 V	4400-2050	09392	8131-M050-651-104M	
DIODES					
CR1	Type 1N3604	6082-1026	99180	1N3604	
VR1	Type 1N750A	6083-1028	07910	1N750A	5960-754-5897
INTEGRATED CIRCUITS					
U1 and U2	Type μA776	5432-1039	93916	μA776	
RESISTORS					
R1	Comp., 2 kΩ, ±5%, 1/4 W	6099-2205	00912	CB, 2 kΩ, ±5%	
R2	Film, 2.23 kΩ, ±1%, 1/8 W	6250-1223	12928	CEA, 2.23 kΩ, ±1%	
R3	Pot. Cermet, Multi, 5 kΩ, ±20%	6049-0188	03920	3006P-1-502	
R5	Film, 9.09 kΩ, ±1%, 1/8 W	6250-1909	12928	CEA, 9.09 kΩ, ±1%	
R6 and R7	Film, 50 kΩ, ±1%, 1/8 W	6250-2500	12928	CEA, 50 kΩ, ±1%	
R8	820 kΩ, ±5%, 1/4 W	6099-4825	00912	CB, 820 kΩ, ±5%	
R9 and R10	Comp., 2 kΩ, ±5%, 1/4 W	6099-2205	00912	CB, 2 kΩ, ±5%	
R11	Film, 2 Ω, ±2%, 300 PPM	6619-2802	06992	A20, 2 Ω ±2%	
R12	Film, 10 kΩ, ±1%, 1/8 W	6250-2100	12928	CEA, 10 kΩ, ±1%	
R13	Pot Cermet, 5 kΩ, ±30%	6049-0108	03920	3329H-1-53	
R14	820 kΩ, ±5%, 1/4 W	6099-4825	00912	CB, 820 kΩ, ±5%	
R15	Film, 75 kΩ, ±1% 1/8 W	6250-2750	12928	CEA, 75 kΩ, ±1%	
R16	Comp., 10 kΩ, ±5%, 1/4 W	6099-3105	00912	CB, 10 kΩ, ±5%	
R17	Comp., 47 Ω, ±5%, 1/4 W	6099-0475	00912	CB, 47 Ω, ±5%	
TRANSISTORS					
Q1	Type 2N4919	8210-1145	04713	2N4919	
Q2	Type 2N1132	8210-1153	04713	2N1132	

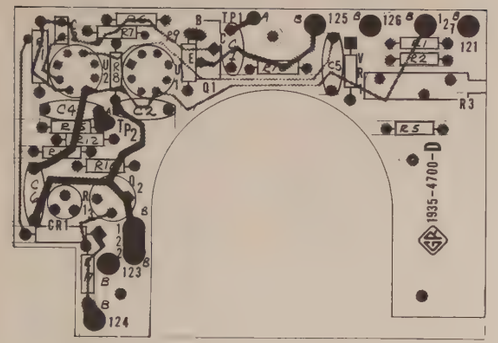


Figure 5-10. Etched-circuit diagram, motor-speed-control board — D (P/N 1935-4700).

NOTE: *Orientation:* Viewed from parts side. *Part number:* Refer to caption. *Symbolism:* Outline area = part; ckt pattern = parts side. *Pins:* Square pad in ckt pattern = collector, I-C pin 1, cathode (of diode), or + end (of capacitor).

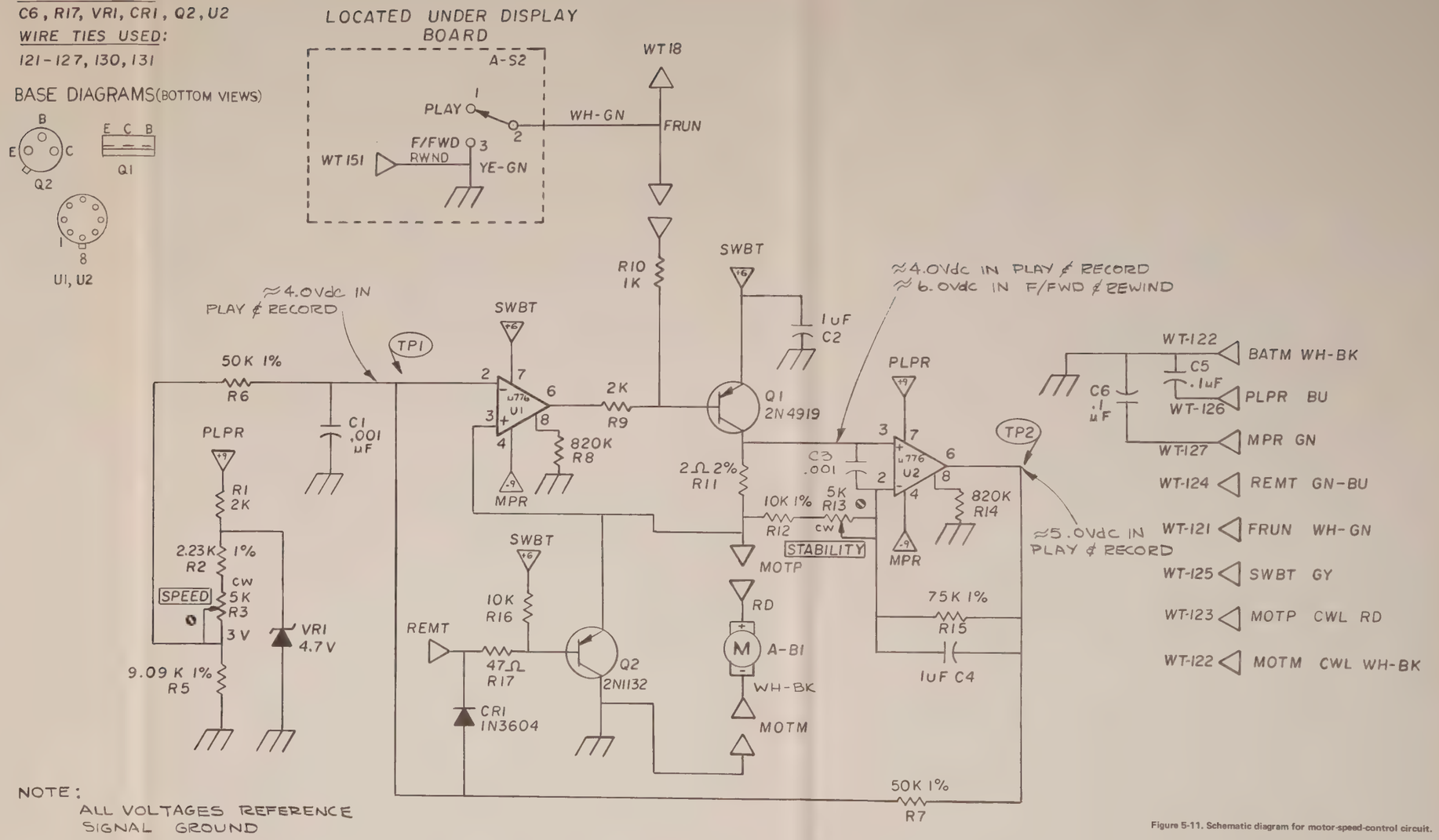


Figure 5-11. Schematic diagram for motor-speed-control circuit.

FEDERAL MANUFACTURER'S CODE

From Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) as supplemented through August, 1968.

Code	Manufacturer
00192	Jones Mfg. Co., Chicago, Illinois
00656	Waisco Electronics Corp, L.A., Calif.
00853	Schweber Electronics, Westburg, L.I., N.Y.
00656	Aerovox Corp, New Bedford, Mass.
00779	Amp Inc., Harrisburg Pa., 17105
01009	Alden Products Co, Brockton, Mass
01121	Allen Bradley Co, Milwaukee, Wisc
01295	Leeds Radio Company, N.Y.
01255	Litton Industries Inc, Beverly Hills, Calif
01295	Texas Instruments, Inc, Dallas, Texas
01454	Ferroxcube Corp, Saugerties, N.Y. 12477
01502	Fenwal Lab Inc, Morton Grove, Ill
01526	Amphenol Electron Corp, Broadview, Ill.
01561	Fastex, Des Plaines, Ill 60016
01604	Carter Ink Co, Camb Mass 02142
01704	G.E. Semicon Prod, Syracuse, N.Y. 13201
01917	Grayburne, Yonkers, N.Y. 10701
01928	Pyrofilm Resistor Co, Cedar Knolls, N.J.
01931	Claires Corp, New York, N.Y. 10001
01939	Arrow-Hart & Hegeman, Hart., Conn. 06106
01964	Digitronics Corp., Albertson, N.Y. 11507
01971	Motorola, Phoenix, Ariz 85008
02170	Engr'd Electronics, Santa Ana, Calif. 92702
02674	Barber-Colman Co, Rockford, Ill. 61101
02735	Barnes Mfg. Co., Mansfield, O. 44901
02820	Wakefield Eng. Inc, Wakefield, Mass. 01880
02943	Crevite Corp., Cleveland, O. 44110
02951	Nuclear Corp.,of America, Inc., Phoenix, Ariz
03126	Digitron Co. Pasadena, Calif.
03127	Eagle Signal (E.W. Bliss Co.), Baraboo, Wisc.
03253	Cinch-Graphik, City of Industry, Calif.
03261	Avnet Corp, Culver City, Calif. 90230
03797	Fairchild Camera, Mountain View, Calif
03877	Bircher Corp, No. Los Angeles, Calif
03508	Amer Semicond, Arlington Hts, Ill 60004
03928	Bodine Corp, Bridgeport, Conn. 06605
03974	Bodine Electric Co, Chicago, Ill 60618
04041	Cont Device Corp, Hawthorne, Calif
04096	State Labs Inc, N.Y., N.Y. 10003
04220	Borg Inst., Delavan, Wisc 53115
04297	Vemaline Prod Co., Franklin Lakes, N.J
04331	G.E. Semiconductor, Buffalo, N.Y.
04350	Star Tronics Inc, Georgetown, Mass 01830
04662	Burgess Battery Co, Freeport, Ill
04602	Burndy Corp, Norwalk, Conn 06852
04713	C.T.S of Berne, Inc, Berne, Ind 46711
04736	Chandler Evans Corp, W. Hartford, Conn
04743	National Semiconductor, Danbury, Conn. 120
04865	Transitron Electronic Corp., E. Boston, Mass
04881	Crystalonics, Cambridge, Mass.02140
04901	Homlin, Inc., Lake Mills, Wisc 53551
04915	RCA, Woodbridge, N.J
04930	Clarostat Mfg Co, Inc, Dover, N.H. 03820
04944	Dickson Electronics, Scottsdale, Ariz
04966	Solitron Devices, Tappan, N.Y. 10983
04973	ITT Semiconductors, W Palm Beach, Fla
04981	Cornell-Dubilier Electric Co., Newark, N.J
04984	Corning Glass Works, Corning, N.Y.
04990	General Instrument Corp, Hicksville, N.Y
05116	Microdot Magnetics Inc, Los Angeles, Calif
05200	ITT, Semiconductor Div, Lawrence, Mass
05235	Cutler Hammer Inc, Milwaukee, Wisc 53233
05245	Spruce Pine Mica Co, Spruce Pine, N.C
05250	Indiana General Corp, Oglesby, Ill 61348
05277	Singer Co, Diehl Div, Somerville, N.J.
05280	Siliconix, Inc., Sunnyvale, Calif. 94086
05298	Voltronics Corp, Hanover, N.J. 07936
05397	Illinois Tool Works, Paketon Div, Chicago, Ill
05446	Computer Diode Corp, S. Farrlawn, N.J. 07410
05497	Cabtron Corp., Chicago, Ill 60622
05624	LRC Electronics, Horseheads, N.Y
05683	Electra Mfg Co, Independence, Kansas 67301
05704	KMC Semiconductor Corp., Long Valley, N.J 07853
05735	Fafnir Bearing Co, New Briton, Conn
05795	UID Electronics Corp, Hollywood, Fla
05820	Avnet Electronics Corp, Franklin Park, Ill
05828	G.E., Schenectady, N.Y. 12305
05853	G.E., Electronics Comp, Syracuse, N.Y
05866	G.E. (Lamp Div.), Nela Park, Cleveland, Ohio
05882	General Radio Co, W. Concord, Mass 01781
05888	American Zettlet Inc, Costa Mesa, Calif
05890	Hayman Mfg Co, Kenilworth, N.J
05900	Hoffman Electronics Corp, El Monte, Calif
05907	Beckman Instruments Inc, Cedar Grove, N.J 07009
05953	I.B.M., Armonk, New York
06011	Jensen Mfg. Co, Chicago, Ill 60638
06137	G.E. Comp, Owensboro, Ky 42301
06141	Koehler Mfg. Co. Inc., Marlboro, Mass 01752
06179	Constanta Co, Mont 19, Que

Code	Manufacturer
37942	P.R. Mallory & Co Inc, Indianapolis, Ind.
38443	Marlin-Rockwell Corp, Jamestown, N.Y.
40931	Honeywell Inc, Minneapolis, Minn. 55408
42190	Muter Co, Chicago, Ill 60638
42498	National Co, Inc, Melrose, Mass. 02176
43991	Norma-Hoffman, Stanford, Conn 06904
49671	RCA, New York, N.Y. 10020
49956	Raytheon Mfg Co, Waltham, Mass. 02154
53021	Sangamo Electric Co, Springfield, Ill 62705
54294	Shallcross Mfg Co, Selma, N.C.
54715	Shure Brothers, Inc, Evanston, Ill.
56289	Sprague Electric Co, N. Adams, Mass
59730	Thomas and Betts Co, Elizabeth, N.J. 07207
59875	TRW Inc, (Accessories Div), Cleveland, Ohio
60299	Torrington Mfg Co, Torrington, Conn
61637	Union Carbide Corp, New York, N.Y. 10017
61864	United Carr Fastener Corp, Boston, Mass
63060	Victoreen Instrument Co, Inc, Cleveland, O.
63743	Ward Leonard Electric Co, Mt. Vernon, N.Y.
65083	Westinghouse (Lamp Div), Bloomfield, N.J.
65092	Weston Instruments, Newark, N.J.
70485	Atlantic-India Rubber, Chicago, Ill 60607
70563	Amperite Co, Union City, N.J. 07087
70903	Belden Mfg Co, Chicago, Ill 60644
71126	Bronson, Homer D, Co, Beacon Falls, Conn.
71279	Cambridge Thermionic Corp, Camb. Mass. 02138
71294	Canfield, H.O Co, Clifton Forge, Va. 24422
71400	Bussman (McGraw Edison), St. Louis, Mo.
71450	CTS Corp., Elkhart Ind. 46514
71468	ITT Cannon Elec, L.S., Calif. 90031
71590	Centralab, Inc, Milwaukee, Wisc. 53212
71666	Continental Carbon Co, Inc, New York, N.Y
71729	Crescent Box Corp, E. Phila, Penn. 19134
71707	Coto Coil Co Inc, Providence, R.I.
71744	Chicago Minature Lamp Works, Chicago, Ill.
71785	Cinch Mfg Co, Chicago, Ill 60624
71823	Darnell Corp, Ltd, Downey, Calif. 90241
72136	Electro Motive Mfg Co, Wilmington, Conn
72259	Nytronics Inc, Berkeley Heights, N.J. 07922
72619	Dialight Co, Brooklyn, N.Y. 11237
72699	General Instr Corp, Newark, N.J. 07104
72765	Drake Mfg Co, Chicago, Ill. 60656
72825	Hugh H. Eby Inc, Philadelphia, Penn. 19144
72962	Elastic Stop Nut Corp, Union, N.J. 07083
72982	Erie Technological Products Inc, Erie, Penn
73138	Beckman Inc, Fullerton, Calif. 92634
73445	Amperex Electronics Co, Hicksville, N.Y.
73559	Carling Electric Co, W. Hartford, Conn.
73690	Elco Resistor Co, New York, N.Y.
73899	JFD Electronics Corp, Brooklyn, N.Y. 11219
74193	Heinemann Electric Co, Trenton, N.J.
74861	Industrial Condenser Corp, Chicago, Ill 60618
74868	Amphenol Corp, Danbury, Conn 06810
74970	E.F. Johnson Co, Waseca, Minn 56093
75042	IRC Inc, Philadelphia, Penn. 19108
75382	Kulka Electric Corp, Mt. Vernon, N.Y.
75491	Lafayette Industrial Electronics, Jamaica, N.Y.
75608	Linden and Co, Providence, R.I.
75915	Littelfuse, Inc, Des Plaines, Ill. 60016
76005	Lord Mfg Co, Erie, Penn. 16512
76149	Mallory Electric Corp, Detroit, Mich. 48204
76487	James Millen Mfg. Co., Malden, Mass 02148
76545	Mueller Electric Co., Cleveland, Ohio 44114
76684	National Tube Co, Pittsburg, Penn
76854	Oak Mfg Co, Crystal Lake, Ill.
77147	Patton-MacGuyer Co, Providence, R.I
77166	Pass-Seymour, Syracuse, N.Y.
77263	Pierce Roberts Rubber Co, Trenton, N.J.
77339	Positive Lockwasher Co, Newark, N.J
77342	American Machine & Foundry Co, Princton, Ind. 47570
77542	Ray-O-Vac Co, Madison, Wisc.
77630	TRW, Electronic Comp, Camden, N.J 08103
77638	General Instruments Corp, Brooklyn, N.Y.
78189	Shakeproof (Ill. Took Works), Elgin, Ill 60120
78277	Sigma Instruments Inc, S. Braintree, Mass
78488	Stackpole Carbon Co, St. Marys, Penn
78553	Tinnerman Products, Inc, Cleveland, Ohio
79089	RCA, Rec Tube & Semicond, Harrison, N.J
79725	Weremold Co, Hartford, Conn 06110
79963	Zierick Mfg Co, New Rochelle, N.Y.
80009	Tektronix Inc, Beaverton, Ore. 97005
80030	Prestole Fastener, Toledo, Ohio
80048	Vickers Inc, St. Louis, Mo
80131	Electronic Industries Assoc, Washington, D.C
80183	Sprague Products Co, No. Adams, Mass
80211	Motorola Inc., Franklin Park, Ill. 60131
80258	Standard Oil Co, Lafeyette, Ind
80294	Bourns Inc, Riverside, Calif. 92506
80368	Sylvania Electric Products Inc, N.Y. 10017

Code	Manufacturer
80431	Air Filter Corp, Milwaukee, Wisc 53218
80583	Hammarlund Co, Inc, New York, N.Y.
80740	Beckman Instruments, Inc, Fullerton, Calif.
80894	Pure Carbon Co., St. Marys, Penn. 15857
81030	International Instrument, Orange, Conn.
81073	Grayhill Inc, LaGrange, Ill. 60525
81143	Isolantite Mfg Corp, Stirling, N.J 07980
81349	Military Specifications
81350	Joint Army-Navy Specifications
81386	Fenwal Electronics, Framingham, Mass. 01701
81483	International Rectifier Corp, El Segundo, Calif 90245
81751	Columbus Electronics Corp, Yonkers, N.Y.
81831	Filtron Co, Flushing, L.I., N.Y. 11354
81840	Ledex Inc, Dayton, Ohio 45402
81866	Barry-Wright Corp, Watertown, Mass
82219	Sylvania Elec Prod, Emporium, Penn.
82293	Indiana Pattern & Model Works, LaPort, Ind
82389	Switchcraft Inc, Chicago, Ill. 60630
82647	Metals & Controls Inc, Attleboro, Mass
82807	Milwaukee Resistor Co, Milwaukee, Wisc
82877	Rotron Mfg. Co. Inc., Woodstock, N.Y. 12498
83032	Meissner Mfg. (Maguire Ind) Mt. Carmel, Ill.
83058	Carr Fastener Co, Cambridge, Mass
83186	Victory Engineering, Springfield, N.J. 07081
83261	Bearing Specialty Co, San Francisco, Calif.
83487	Solar Electric Corp, Warren, Penn.
83740	Union Carbide Corp, New York, N.Y. 10017
83781	National Electronics Inc, Geneva, Ill
84411	TRW Capacitor Div, Ogallala, Nebr
84396	Lehigh Metal Prods, Cambridge, Mass. 02140
84971	TA Mfg Corp, Los Angeles, Calif
86577	Precision Metal Prods, Stoneham, Mass. 02180
86684	RCA (Elect. Comp & Devl, Harrison, N.J.
86837	REC Corp., New Rochelle, N.Y. 10801
86880	Cont Electronics Corp, Brooklyn, N.Y. 11222
88140	Cutler-Hammer Inc, Lincoln, Ill.
88219	Gould Nat. Batteries Inc, Trenton, N.J.
88419	Cornell-Dubilier, Fuquay-Varina, N.C.
88627	K & G Mfg Co, New York, N.Y.
89482	Holtzer-Cabot Corp, Boston, Mass
89565	United Transformer Co, Chicago, Ill.
90201	Mallory Capacitor Co, Indianapolis, Ind.
90634	Gulton Industries, Inc, Metuchen, N.J. 08840
90750	Westinghouse Electric Corp, Boston, Mass
90952	Hardware Products Co, Reading, Penn 19602
91032	Continental Wire Corp, York, Penn. 17405
91146	ITT (Cannon Electric Inc), Salem, Mass
91310	Gerber Mfg. Co, Mishawaka, Ind.
91383	Johanson Mfg Co, Boonton, N.J. 07005
91506	Augat Inc, Attleboro, Mass 02703
91598	Chandler Co, Wethersfield, Conn 06109
91637	Dale Electronics Inc, Columbus, Nebr
91662	Elco Corp, Willow Grove, Penn
91711	General Instruments, Inc, Dallas, Texas
91926	Mephisto Tool Co. Inc, Hudson, N.Y. 12534
91929	Honeywell Inc, Freeport, Ill.
92616	Electra Insul Corp, Woodside, L.I., N.Y.
92629	E.G.&G., Boston, Mass.
92736	Ampex Corp, Redwood City, Calif 94063
92832	Sylvania Elect Prods, Inc, Woburn, Mass
93418	R. & C Mfg. Co. of Penn, Inc, Ramey, Penn
93410	Cramer Products Co, New York, N.Y. 10013
93424	Raytheon Co, Components Div, Quincy, Mass.
93553	Tung Sol Electric Inc, Newark, N.J.
93791	Weston Instruments Inc, Archibald, Penn 18403
94589	Dickson Co., Chicago, Ill. 60619
94800	Atlas Industrial Corp., Brooklyn, N.H.
95076	Garde Mfg. Co., Cumberland, R.I.
95121	Quality Components Inc, St. Mary's, Penn.
95146	Alco Electronics Mfg Co, Lawrence, Mass
95238	Continental Connector Corp, Woodside, N.Y.
95275	Vitramon, Inc, Bridgeport, Conn.
95354	Methode Mfg Co, Chicago, Ill.
95412	General Electric Co, Schenectady, N.Y
95794	Anaconda Amer Brass Co, Torrington, Conn.
96090	Hi-Q Div. of Aerovox Corp, Orlean, N.Y.
96214	Texas Instruments Inc, Dallas, Texas 75209
96256	Thorderson-Messner, Mt. Carmel, Ill.
96341	Microwave Associates Inc, Burlington, Mass.
96791	Amphenol Corp, Janesville, Wisc. 53545
96906	Military Standards
97464	Models Inc, North Bergen, N.J
98291	Sealectro Corp, Mamaroneck, N.Y. 10544
98474	Compar Inc, Burlingame, Calif
98821	North Hills Electronics Inc, Glen Cove, N.Y
99117	Meravac Inc, Flushing, N.Y. 11358
99180	Transitron Electronics Corp, Melrose, Mass
99314	Varian, Palo Alto, Calif 94303
99375	Atlee Corp, Winchester, Mass. 01890
99806	Delevan Electronics Corp, E. Aurora, N.Y.

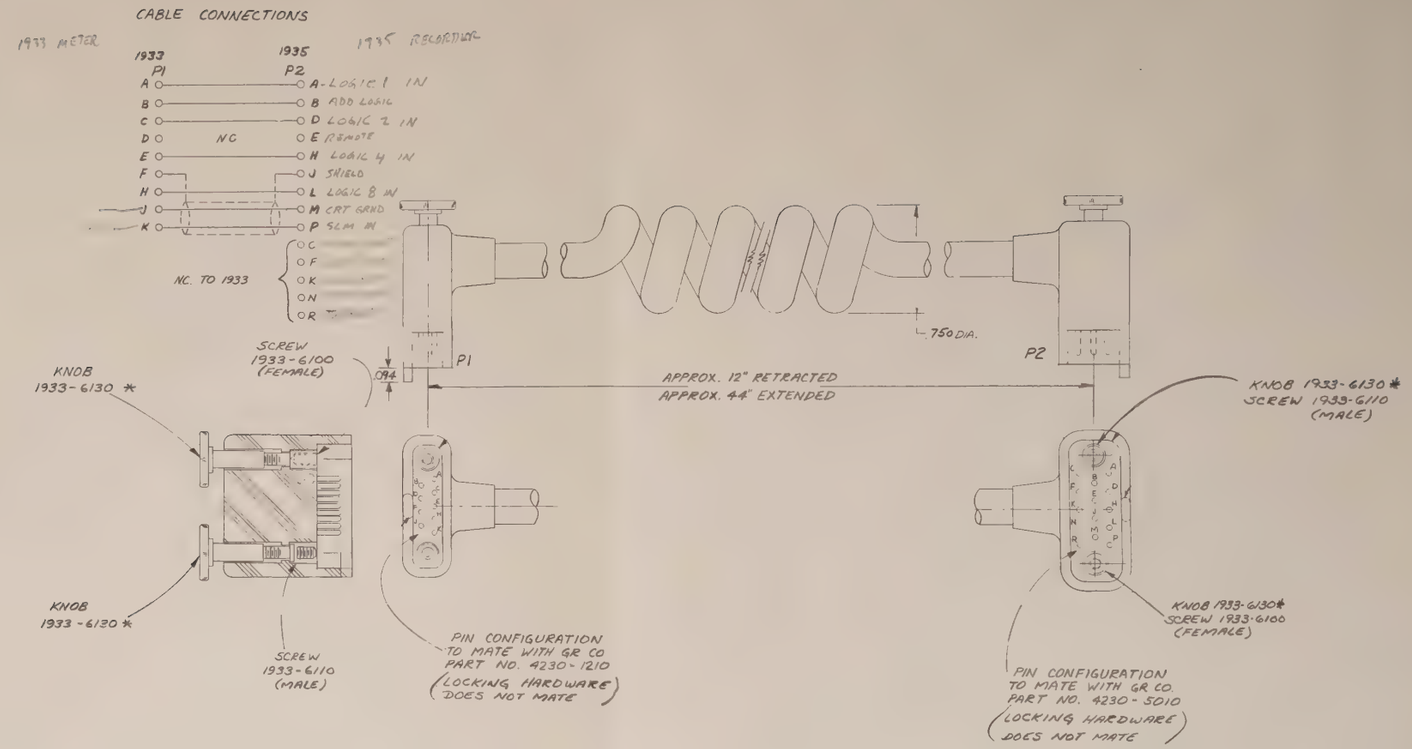


Figure 5-12. Wiring diagram for interconnecting cable, P/N 1935-0231.

GR 1940 POWER SUPPLY and CHARGER

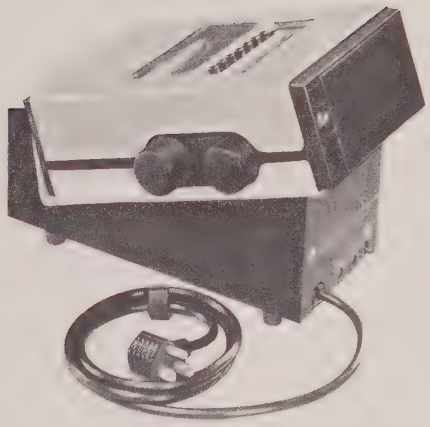


Figure 1. Type 1940 Power Supply and charger shown with GR 1933 installed.

Description	Catalog Number
1940 Power Supply and Charger	1940-9701

SPECIFICATIONS

Power Source: 5 V for line operation of 1933, 6.5 V for line operation of 1935; 250 mA max.

Charging Source: 200 mA max for charging batteries in 1933 or 1935; automatically reduces to ≈ 30-mA trickle charge when batteries are charged. Charging time ≈ 16 h.

Supplied: 5 rechargeable nickel-cadmium C cells to replace non-rechargeable batteries in 1933 or 1935.

Power: 100 to 125 or 200 to 250 V, 50 to 400 Hz, 11 W.

Mechanical: DIMENSIONS (wxhxd): 4.38x4.25x9.44 in. (111x108x240 mm). WEIGHT: 3.5 lb (1.5 kg) net, 5 lb (2.3 kg) shipping.

INTRODUCTION.

The 1940 Power Supply and Charger includes two independent sources, a power source and a charging source. The power source provides for line operation of either the 1933 Precision Sound-Level Meter and Analyzer or the 1935 Cassette Data Recorder, complerely independent of the instrument's batteries. It operates from line voltages between 100-125 and 200-250-V, 50-400 Hz. The charging source charges the batteries in either instrument.

It is supplied with five rechargeable cells (to replace the ordinary C cells supplied in the analyzer or recorder).

OPERATION.

There are no internal connections to make; the instruments simply plug into the 1940 and are supported at a convenient angle for bench-top operation, (Figure 1).

Dimensions for the unit are shown in Figure 2.

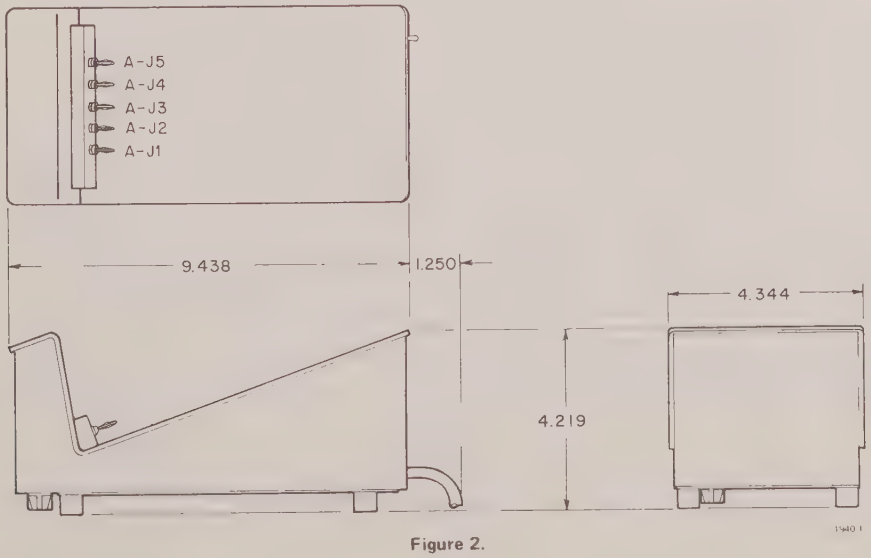


Figure 2.

CIRCUIT DESCRIPTION.

See the schematic diagram (Figure 5) for circuits referred to in the following description.

The regulator circuits for both sources are supplied from a common rectifier and filter-capacitor circuit. When the line voltage is applied, the POWER LINE indicator lamp, DS1, lights. It is fed from a constant-current source consisting of transistor Q8, diode CR11, and resistors R16 and R17.

The regulator circuit for the charging source consists of integrated circuit U1 and transistors Q3, Q4, and Q5. Q3 is a FET that operates as a constant-current source for diode VR1, which provides a reference to one input of U1. The other input of U1 is driven from a voltage proportional to the voltage being regulated. U1 controls the base current fed to transistor Q5. When the output current increases, so that the voltage drop across R4 and parallel diodes CR12 and CR13 exceeds 1.2 V, transistor Q4 conducts. This diverts the base current of Q5 and shuts it off. The parallel diodes and R4 limit the current from the collector of Q5 to 200 mA, the required charging current for the nickel-cadmium batteries used in the Analyzer and Recorder.

A charging period of 14-16 hours is required to fully charge batteries. Potentiometer R9 (TRICKLE CHG) sets the trickle charge current, which is approximately 30 mA. The trickle charge is adjusted for Gould Nicad 2.0 SCB batteries; if other batteries are used, the trickle charge must be reset.

Diodes CR6, CR7, and CR8 prevent the interaction of the charging and the power source supplies. For the 1935, only CR6 is used in series with the charging supply, for the 1933, three diodes are used. The two additional diodes in the 1933 line give a voltage drop about equal to that of one battery cell.

Transistors Q1 and Q2 form the BATTERY CHARGED circuit. They sense the voltage drop across the series combination of R4, CR12, and CR13. When the voltage across this network drops below 0.6 V, transistor Q2 is turned off and base current for Q1 is supplied through resistor R2. Q1 is turned on and lights the indicator lamp DS2 (BATTERY CHARGED).

The regulator circuit for the line power source consists of integrated circuit U2 and transistors Q6 and Q7, and functions similarly to the charging supply. The reference for this supply is derived from diode VR1. A voltage drop of 0.6 V, across R11, limits the output current to approximately 250 mA.

Two diodes, CR9 and CR10, in series with the output to the 1933, give a voltage drop about equal to that of one battery cell.

SERVICE AND MAINTENANCE.

Table 1
TEST EQUIPMENT RECOMMENDED

Instrument	Requirements	Recommended*
Wave Analyzer	Continuous, 20 Hz to 54 kHz	GR 1900
Variac® autotransformer, metered	Nominal line voltage of 120 V with meters for amps, volts and watts.	GR W5MT3AW
Volt/Ohmmeter electronic	Voltage range to 250 Vac; ohms range to 10 MΩ.	GR 1806
Oscilloscope	General purpose, low frequency	Tektronix type 547, 1 A 1 plug-in
Ammeter	Dc, 0–500 mA	Commercial
Potentiometer	Wirewound, 0–250 ohms, 10 W	Commercial

*Or equivalent.

Ohmmeter Checks (RX10K) (Figure 2)

a. With no power applied, set BATT/LINE to 'LINE' and connect the ohmmeter –side to J1.

b. Check that A-J1 – A-J2 reads 20 kΩ
A-J1 – A-J3 reads 1 MΩ
A-J1 – A-J4 reads 1 MΩ
A-J1 – A-J5 reads 1 MΩ

c. Check that high side of line to low side reads 150 Ω in 100 – 125 V, 500 Ω in 200 – 250 V positions of power switch, A-S2.

d. Set BATT/LINE switch to 'BATT' test for 0 ohms between J3 and J5 and between J2 and J4.

Input Power Check.

Plug the power cord into the Variac and rotate the Variac control slowly to 115 V. The Variac Wattmeter should read between 2 – 3 W. Both BATTERY CHARGED and PWR line lights should be lighted.

Charge Current Check.

Make the following connections:

1940 – Line . . . . . Connect to Variac
Variac . . . . . Set for 115 V out
1940 Power switch . . . . . 'Line' operation (down).
Load (See Fig. 3) . . Connect load fixture to J1 and J4 of 1940 (J1 is (–) side)

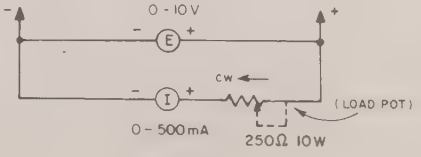


Figure 3.

1940 2

b. Adjust load pot for 35 mA current. Adjust R9 (trickle charge) to give a voltage of 7.1 V across J1/J4.

c. Rotate the load pot cw to give a reading of 5.5 V across J1/J4. The current should be between 190 – 210 mA. Rotate the load pot fully cw. The voltage should drop smoothly to 0 V and the current remain constant at 190 – 210 mA.

d. Move the load fixture to J1 – J5 (J1 is (–)); adjust variable pot for 35 mA. The voltage should read 5.6 – 5.8 V.

e. Adjust the load pot to give a reading of 4.5 V. The ammeter should read 190 –210 mA. Rotate the load pot fully cw. The voltage should drop smoothly to 0 V and the current remain constant at 190 – 210 mA.

f. Rotate the load pot ccw until the BATTERY CHARGED light comes on. The current should read 110 mA or less. Adjust R9 if required.

Load Current Checks.

a. Connect the load fixture (Figure 3) to J1 (–) and J2. Adjust the load pot until the voltage reads 5.5 V. The current should read 250 – 275 mA. Adjust the load pot fully cw; the voltage should drop smoothly to 0 V and the current remain constant. Set the load pot fully ccw; the voltage should read 6.4 – 6.6 V.

b. Connect the load fixture to J1 (–) and J3 (+). Adjust the load pot until the voltage reads 4.0 V. The current should read 250 – 275 mA. Adjust the load pot fully cw. The voltage should drop smoothly to 0 V and the current remain constant. Set the load pot fully ccw; the voltage should read 5.1 – 5.3 V.

Line Regulation Check

a. Connect the load fixture to the terminals indicated on Table 2. Adjust the load pot for 150 mA in each case. Adjust the Variac output between 95 and 130 Vac. Note the change in voltage at the terminals tested.

b. With the oscilloscope measure the noise at the terminals for the same conditions listed in table 2.

Table 2
LINE REGULATION

Connect Load Fixture to Terminal – +	Load Current (mA)	Regulation (V)	Ripple (mV)	RMS Hum (Each Component) (mV)
J1 – J2	150	< 0.1	< 10	< 1.5
J1 – J3	150	< 0.1	< 10	< 1.5
J1 – J4	150	< 0.1	< 50	< 1.5
J1 – J5	150	< 0.1	< 50	< 1.5

Hum Check.

Measure the RMS voltage of each component with a 1900 at the conditions listed in Table 2. Measure 60, 120 and 180 Hz.

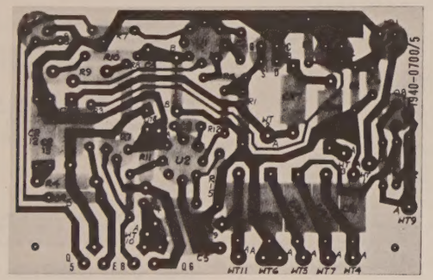


Figure 4. Etched circuit diagram (P/N 1940-4700).

NOTE: *Orientation:* **Viewed from foil side.** *Part number:* **Refer to caption.** *Symbolism:* **Outlined area = part; gray ckt pattern (if any) = parts side, black = other side.** *Pins:* **Square pad in ckt pattern = collector, I-C pin 1, cathode (of diode), or + end (of capacitor).**

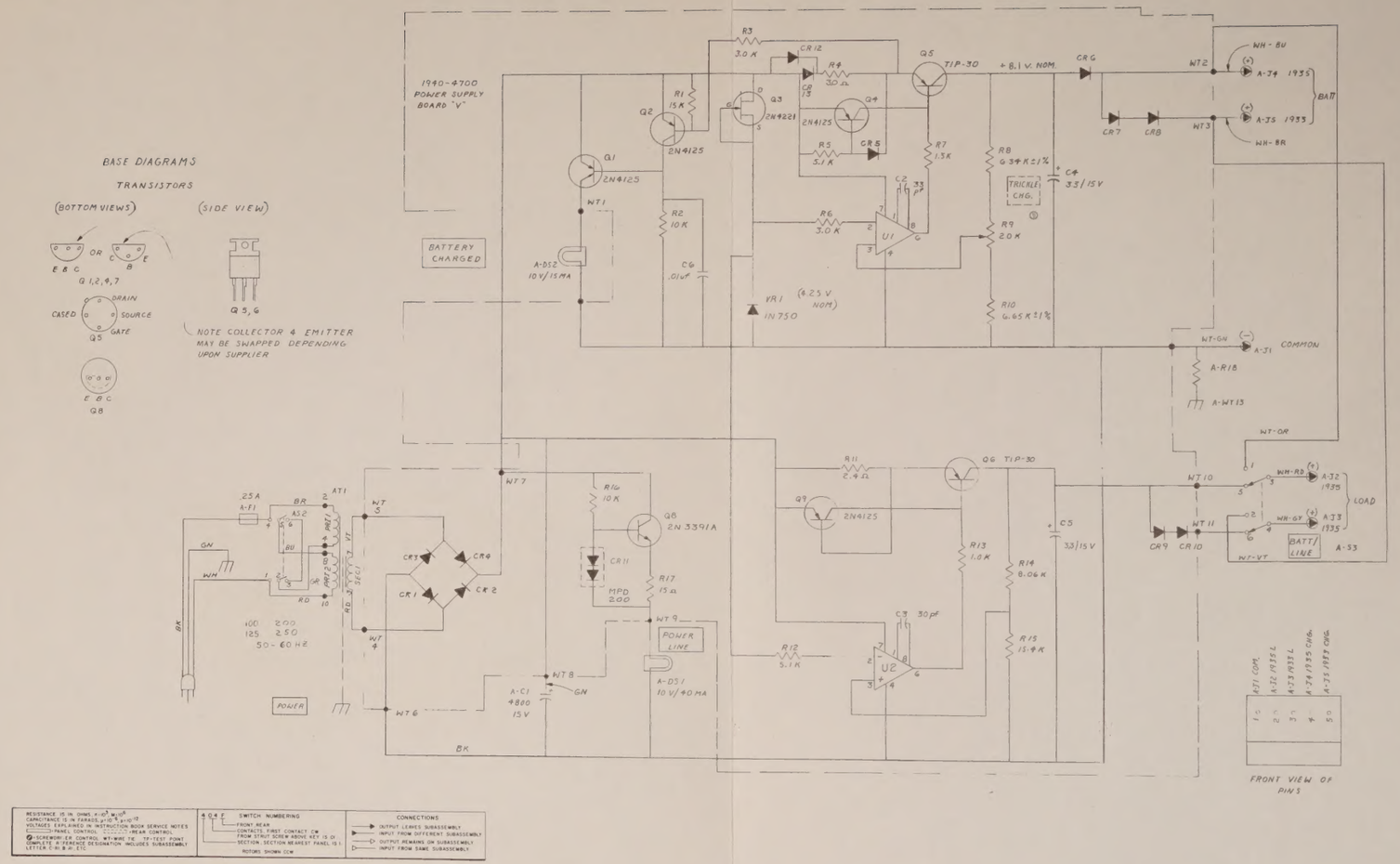


Figure 4. Schematic Diagram for 1940 Power Supply and Charger.

ELECTRICAL PARTS LIST

Ref Des	Description	GR Part No.	Fed Mfg Code	Mfg Part No.	Fed Stock No.
A-C1	Capacitor, 4800 μF, 15 V	4450-4200	37942	20-21339-99-6	
A-DS1	Lamp, 6 V	5600-0316	71744	# 345	6210-082-0583
A-DS2	Lamp, 10 V	5600-0314	71744	# 344	5920-933-5435
A-F1	Fuse, 1/4 A	5330-0700	71400	MDL, 0.25 AMP	
A-J2-6	Plug Asm	0274-3610	24655	0274-3610	
A-J2-6	Terminal, .138-32	7930-1600	78189	2120-06-00	5905-190-8883
A-R18	Resistor, 10 Ω, ±5%, 1/2 W	6100-0105	01121	RC20GF100J	
A-S2	Switch, Slide, DPDT	7910-0832	82389	11A-1118	
A-S3	Switch, Toggle, 2 Pos, DPDT	7910-0791	95146	MST-205N	
A-T1	Transformer Asm	0745-4590	24655	0745-4590	
	CAPACITORS				
C2 and C3	Ceramic, 33 pF, ±5%, 500 V	4404-0335	72982	831, 33 pF, ±5%	
C4 and C5	Tantalum, 3.3 μF, ±10%, 15 V	4450-4601	01295	15335C2	
C6	Ceramic, 0.01 μF, +80-20%, 100 V	4401-3100	80131	CC61, 0.01 μF, +80-20%	5910-974-5697
	DIODES				
CR1 thru CR4	Type 1N4003	6081-1001	14433	1N4003	
CR5	Type 1N4009	6082-1012	24446	1N4009	5961-892-8700
CR7 and CR8	Type 1N4140	6081-1014	13327	1N4140	
CR9 and CR10	Type 1N4003	6081-1001	14433	1N4003	
CR11	Type MPD200	6082-1033	06751	MPD-200	
CR12 and CR13	Type 1N455	6082-1010	07910	1N455	5960-877-8255
VR1	Type 1N750A	6083-1028	07910	1N750A	5960-754-5897
	INTEGRATED CIRCUITS				
U1 and U2	LM301A	5432-1004	12040	LM301A	
	RESISTORS				
R1	15 kΩ, ±5%, 1/4 W	6099-3155	75042	BTS, 15 kΩ, ±5%	5905-681-8818
R2	10 kΩ, ±5%, 1/4 W	6099-3105	75042	BTS, 10 kΩ, ±5%	5905-683-2238
R3	3 kΩ, ±5%, 1/4 W	6099-2305	75042	BTS, 3 kΩ, ±5%	5905-682-4097
R4	3.0 Ω, ±5%, 1/4 W	6100-9305	01121	EB, 3.0 Ω, ±5%	
R5	5.1 kΩ, ±5%, 1/4 W	6099-2515	75042	BTS, 5.1 kΩ, ±5%	5905-683-2241
R6	3 kΩ, ±5%, 1/4 W	6099-2305	75042	BTS, 3 kΩ, ±5%	5905-682-4097
R7	1.3 kΩ, ±5%, 1/4 W	6099-2135	75042	BTS, 1.3 kΩ, ±5%	5905-686-3119
R8	6.34 kΩ, ±5%, 1/8 W	6250-1634	75042	CEA, 6.34 kΩ, ±1%	
R9	Potentiometer, 2 kΩ, ±10%	6051-2209	07999	2600 PC, 2 kΩ, ±10%	
R10	6.65 kΩ, ±1%, 1/8 W	6250-1665	75042	CEA, 6.65 kΩ, ±1%	5905-855-3178
R11	2.4 Ω, ±5%, 1/4 W	6100-9245	01121	EB, 2.4 Ω, ±5%	
R12	5.1 kΩ, ±5%, 1/4 W	6099-2515	75042	BTS, 5.1 kΩ, ±5%	5905-683-2241
R13	1 kΩ, ±5%, 1/4 W	6099-2105	75042	BTS, 1 kΩ, ±5%	5905-681-6422
R14	8.06 kΩ, ±1%, 1/8 W	6250-1806	75042	CEA, 8.06 kΩ, ±1%	
R15	15.4 kΩ, ±1%, 1/8 W	6250-2154	75042	CEA, 15.4 kΩ, ±1%	5905-557-3775
R16	10 kΩ, ±5%, 1/4 W	6099-3105	75042	BTS, 10 kΩ, ±5%	5905-683-2238
R17	15 Ω, ±5%, 1/4 W	6099-0155	75042	BTS, 15 Ω, ±5%	
	TRANSISTORS				
Q1 and Q2	Type 2N4125	8210-1125	04713	2N4125	
Q3	Type 2N4221	8210-1127	04713	2N4221	
Q4	Type 2N4125	8210-1125	04713	2N4125	
Q5 and Q6	Type TIP-30	8210-1191	96214	TIP-30	
Q7	Type 2N4125	8210-1125	04713	2N4125	
Q8	Type 2N3391A	8210-1092	24454	2N3391A	

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